EMPOWERING AND FACILITATING STUDENT LEARNING: AN INVESTIGATION OF CULTURALLY RELEVANT PEDAGOGY FOR HIGH-SCHOOL MATHEMATICS INSTRUCTION

A Dissertation

by

TARCIA LASHA HUBERT

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Chair of Committee,	Robert M. Capraro
Committee Members,	Chance W. Lewis
	Mary M. Capraro
	Bruce Thompson
	Jacqueline Leonard
Head of Department,	Yeping Li

December 2013

Major Subject: Curriculum and Instruction

ABSTRACT

Implementing culturally relevant pedagogy (CRP) in a mathematics classroom is often recommended by researchers as a strategy for improving mathematical achievement among underrepresented students. This study explores the effect of CRP on the mathematical achievement of underrepresented students by: 1) conducting a meta-synthesis in order to determine the effects that have been found in prior culturally relevant mathematics studies; 2) contributing to the literature on the effect by engaging high school students in a 10-day culturally relevant mathematics intervention and measuring their mathematical achievement by a pre- and post- assessment; and 3) determining students' perspectives of culturally relevant mathematics instruction by interviewing five students that participated in the culturally relevant intervention.

The results of investigating CRP revealed that it has positive impacts for all students participating. Not only did CRP improve mathematics achievement among all students, but CRP also increased students': 1) engagement in the learning process; 2) life-skills; 3) habits of learning; 4) general knowledge; 5) community advocacy; 6) attitudes; 7) and interests in mathematics. Also, the students in the study had positive perspectives of CRP and preferred CRP over traditional mathematics instruction. Broader impacts of the results from this study are also provided.

DEDICATION

I would like to dedicate this dissertation to the following:

- My Lord and Savior Jesus Christ who is the head of my life, and who has given me all that I need to complete this study.
- My husband, Derrick, who has been there for me to motivate me when I needed someone the most.
- My unborn son, who challenged me to push myself even harder due to the pregnancy.
- My parents, Mae and Curtis for always pushing me to give my best and do whatever my heart desires, to follow my dreams.
- My Aunt Tina, who always brought out the best in me. I wish she were here to see me achieve this great accomplishment. Rest in peace Aunt Tina.
- My family and friends who have supported and encouraged me with words, thoughts, expressions, and deeds throughout this tedious process.
- To all that have ever believed in me and to the many children I have worked with throughout the years inspiring them through mathematics.

Thank you all for being a part of my life!

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Robert M. Capraro, and my committee members, Dr. M.M. Capraro, Dr. Lewis, Dr. Thompson, and Dr. Leonard, for their guidance and support throughout the course of this research. Thank you all for challenging my mind to think on various levels. Thank you for being supportive and providing your expertise. Thank you Dr. Robert M. Capraro for taking me under your wings and teaching me all that you could possibly teach me. The wisdom you have imparted has definitely helped me to become a better person. Thank you Dr. M. M . Capraro for helping me stay organized and on top of things related to completing my degree. Thank you Dr. Thompson for helping me to view statistics from a different perspective, and to develop conceptual understandings of statistics. Thank you Dr. Lewis for being open to me and my research and accepting a position on my committee although you were getting ready to transfer schools. Thank you Dr. Leonard for accepting and mentoring me although you did not know me and had never met me. I thank you for sharing your expertise on culturally relevant mathematics pedagogy. Thank you all for the contributions you have made to this research and to my life!

I would also like to thank the principal of the school in which the research was conducted. This individual made it possible for me to teach a group of high school students using culturally relevant mathematics instruction. This individual was open and supportive of my research and made me feel comfortable being on the campus. This person will always have a special place in my heart. Thanks also to all my friends who have also been pursuing their doctorate. We have learned from each other, pushed each other, and encouraged each other. It is great to know a group of people like you (Latoya, Jon, Anna Pat, Rayya, Sunyoung). Thanks also to Aggie STEM for working with me while I was conducting my research. They also provided great support that contributed to my success.

Finally, thanks to my mother and father for their encouragement and to my husband for his patience and love. Thanks to all of my family and friends who have supported me along this journey!

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CHAPTER I

INTRODUCTION

At the 2011 Benjamin Banneker Association Conference in Atlanta, Georgia, Dr. Danny Martin urged researchers interested in the mathematics education of African-American children to "engage in research and argumentation with the brilliance of Black children as axiomatic" (Gholson, Bullock, & Alexander, 2012, p. 2). It is important to note that the terms "African-American" and "Black" are used interchangeably to refer to students of African descent born in America. The new emergence was directed to view the brilliance of Black children as an axiom as opposed to a conjecture. He defined a conjecture as a proposition that has been neither proven nor disproven but is thought to be true. Whereas, an axiom is a self-evident, logical statement assumed to be true yet not proven, but serves as a beginning for deducing and inferring other truths. Therefore, the Black children brilliance axiom assumes that Black children are brilliant without a doubt and this is the basis for continuing research.

The new brilliance of Black children as axiom calls for a new set of research questions that has nothing to do with Black children's achievement because their ability and potential is no longer a question (Bullock, Alexander, & Gholson, 2012). Instead, research should locate or highlight the unique characteristics of Black students, teachers, and classrooms. Fully accepting the call of the Black brilliance axiom, in this research I will not focus on achievement gaps because of the dangerous effects associated with "gap gazing" (Gutiérrez, 2008). The focus will be on effective mathematics teaching and learning environments for Black students, including richer descriptions of those environments through intervention work with an intention of making the research accessible and usable by practitioners (Gutiérrez, 2008).

In the past couple of decades, there have been attempts to create more equitable mathematics classrooms that promote academic excellence. Jackson and Wilson (2012) conducted a literature review to determine how to support African-Americans' substantial participation in mathematics instruction that had rigorous goals. They reported on some areas of promise, but also suggested that a lot of work still needs to be done. Jackson and Wilson (2012) gave recommendations for future research foci to include: 1) forms of instructional practice to support African-American students to participate in rigorous mathematical activity, and 2) African-American students' experiences as learners of mathematics including developing mathematical identities. In this research, the two foci are addressed.

Background

Culturally Relevant Pedagogy (CRP) was developed from a curiosity of a researcher to know and understand best practices for working with African-American students. Ladson-Billings (2009) studied successful teachers of African-American students in an ethnography for an extended period of time. In the process of her analysis of aspects of successful teachers, their classrooms, and their teaching styles, she developed a grounded theory that she termed culturally relevant pedagogy (Ladson-Billings, 1995a). She defined CRP as "a theoretical model that addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools perpetuate"

(Ladson-Billings, 1995b, p. 469). There are three outcomes proposed through CRP: 1) students that can achieve academically; 2) students who demonstrate cultural competence; and 3) students who can both understand and critique the existing social order (Ladson-Billings, 1995b).The commonalities found among successful teachers of African-American students were the foundation for CRP.

There has been increased attention given to scholarship related to CRP since the No Child Left Behind Act to determine how to promote academic excellence for all (Lemons-Smith, 2010). Mathematics success for African-American students may be supported by deeply embedding the mathematics in the students' everyday contexts (Ladson-Billings, 1997) as opposed to using, what Tate (1995) called, a 'foreign pedagogy'. The foreign pedagogy is a repeated cycle of whole class instruction of teacher lecturing, followed by isolated student work on textbook problems similar to problems presented in the lecture (Tate, 1995). Thus mathematics is presented in a way that is divorced from most African-Americans' lived experiences (Ladson-Billings, 1997).Therefore, supportive learning environments for African-American students need to go beyond surface changes such as changing names in word problems, to understanding the deep structures of students' experiences. Some researchers have suggested an effective way to address the cultural mismatch in the mathematics classrooms and to support mathematics learning for African-American students (Brown-Jeffy & Cooper, 2011; Enyedy & Mukhopadhyay, 2007; Leonard, 2008; Tate, 1995).

Research Questions

The purpose of the present study is to investigate how CRP facilitates mathematical learning and empowerment among African-American students (Leonard, Davila, & Stinson, 2012). The corpus of this work is based on mixed-methods and reported as three separate studies. Three articles were produced: 1) Nurturing Mathematical Brilliance in African-American Students: A Meta-Synthesis of Culturally Relevant Mathematics Teaching; 2) Supporting High School Students' Learning of Mathematics: A Culturally Relevant Intervention; 3) Learners of Mathematics: High School Student Perspectives of Culturally Relevant Mathematics Pedagogy. Each article contains its own set of research questions to understand the overarching purpose of how CRP is used to empower and facilitate African-American students learning.

Article 1: Nurturing Mathematical Brilliance in African-American Students: A Meta-Synthesis of Culturally Relevant Mathematics Teaching

The first article is a meta-synthesis of culturally relevant mathematics interventions aimed at addressing: 1) What student results have been produced from prior culturally relevant mathematics research; and 2) How CRP has been used as a source of empowerment for mathematical learning among African-American students.

Participants. Three search engines (Educational Resource Information Center (ERIC), Education Full Text, and Google Scholar) were used to find literature related to culturally relevant mathematics pedagogy. The Boolean phrases "culturally relevant pedagogy" AND "mathematics" and, "culturally relevant teaching" AND "mathematics" were used along with the limiters of years of publication between 1995 and 2012. The search resulted in 419 hits that were reviewed to determine if they met criteria. The established criteria for participation in the study were: 1) engage students in culturally relevant mathematics pedagogy, and 2) report student impacts or outcomes for African-American students. There were a total of seven documents that met both criteria. The major limiting factor was that most articles focused on teacher factors.

The seven documents were disaggregated and coded to discover common themes throughout prior implemented CRP mathematics interventions. The common themes included: 1) attitude; 2) engagement; 3) mathematics achievement; 4) life skills; 5) habits of student learning; 6) community advocacy; and 7) general knowledge. This article addresses relations, contradictions, and gaps in the literature on CRP mathematics student outcomes. One particular gap that exists is the limited amount of research to show CRP as a source of empowerment for mathematical learning among African-American students. The description of this gap leads to a recommendation for future research agendas to focus on demonstrating CRP as a source of empowerment for African-American students' mathematical learning. This recommendation is the direct connection between the first and second article.

Article 2: Supporting High School Students' Learning of Mathematics: A Culturally Relevant Intervention

In article 2, a culturally relevant mathematics intervention was conducted to explore how culturally relevant mathematics instruction affects students' mathematical performance. Students' mathematical performance was assessed before and after they participated in culturally relevant mathematics instruction. The purpose was to determine if African-American students' mathematical performance improved after participating in culturally relevant instruction, and if so, the extent of the improvement.

Participants. A Title 1 high school located in the state of Texas was chosen to conduct the research. The ethnic distribution of the school was 27% African-American, 52% Hispanic, and 21% White. The student population consisted of 73% economically disadvantaged and 99% students placed at-risk. Permission was granted by the school principal and the district to conduct the research at the site. The study focused on a group of 37 students who were participating in a course that was preparing them for the state standardized mathematics assessment. The average class size of a mathematics classroom in this particular school district was 20 students. The principal recommended choosing a sample twice the size of the average class. Forty-two students were selected in case of participant attrition because the attendance rate at this school was an issue of concern. Thirty-seven of the 42 students agreed to participate. The purpose of obtaining a sample of average class size was for the researcher to teach lessons in the typical classroom environment that students see on an everyday basis.

Design and Instrumentation. The design followed a single group pretest-intervention-posttest design. Each test consisted of questions from the mathematics portion of the state standardized assessment from previous years. The pre-test and post-test were the exact same tests. Each test consisted of four questions per lesson covered throughout the intervention. There were eight lessons taught; therefore, there were a total of 32 questions on the pre- and post-tests. The lessons covered topics of quadratic and exponential functions. A Who Am I? Questionnaire was also given to the students to obtain information about the students' culture. The questionnaire gathered data about socio-cultural status, free-time interests, and demographics. The questionnaire was used for developing culturally relevant lessons.

Methods and Analysis. A ten-day culturally relevant intervention took place with the 37 selected students during their assigned assessment preparation class period for two hours each day. The intervention consisted of the researcher engaging the students in eight culturally relevant mathematics lessons developed with the help of the student questionnaires. Therefore, each student had the opportunity to participate in sixteen hours of culturally relevant mathematics instruction.

The results from pre- and post-assessments for each ethnic group are described using descriptive statistics. A *t*-test was conducted to determine if there was growth from pre- to post-assessment and the results were statistically significant for the group of all students and for the individual group of Hispanic students. Cohen's *d* effect sizes were computed to determine the extent of the growth. The groups of Hispanic, Native American, White, and All students' scores resulted in effect sizes falling within the range of .8 to 1.7 while African American and Bi-Racial students had effect sizes falling within the range of .2 to .4. The relationship between the amount of hours of instruction each student participated in, and the difference in pre- and post-assessments was examined in hopes of a strong positive correlation. The Pearson correlation *r* resulted in a perfect positive correlation for Native American students, but a small negative correlation for students overall.

Article 3: Learners of Mathematics: High School Student Perspectives of Culturally Relevant Mathematics Pedagogy

Article three is a case study of students participating in culturally relevant mathematics instruction. The purpose of this article is to determine: 1) what are African-American students' perspectives of culturally relevant mathematics instruction; and 2) whether culturally relevant instruction affects students' attitudes and interests toward mathematics.

Participants. Results of student scores reported in article two were used to select five students to participate in this case study. Participants were selected according to their levels of growth throughout the culturally relevant intervention and their attendance for at least half of the 16 hours of instruction. Table 1 gives further details on each participant.

Table 1

Participant Characteristics

Name	Ethnicity & Gender	Difference in Pre-Post	# of Hours of Instruction
Student 1	African-American Female	-25	12
Student 2	Bi-Racial Female	-12	12
Student 3	White Female	+12	10
Student 4	African-American Male	+13	11
Student 5	Hispanic Female	+34	8

+ indicates an increase in scores and – indicates a decrease in scores

Methods and Analysis. Five participants participated in one-on-one structured interviews with the researcher. The purpose of the interviews was to determine if and how students benefited from culturally relevant instruction, and to obtain their perspectives, feelings, and attitudes towards it. Also, the interviews were conducted to determine if CRP made it easier for the participants to learn mathematics, and if they felt empowered from the instruction. The researcher kept a journal in which field notes were documented throughout each lesson. The field notes documented any experiences that occurred pertinent to the question at hand. The results of the field notes were discussed in this article. All students were also given a questionnaire that contained two open-ended questions regarding their overall feelings toward culturally relevant mathematics instruction.

The three stages of analysis presented by Creswell (2007) were used in this study. They include preparing and organizing the transcribed data, reducing the data into themes, and representing the data in figures, tables, or a discussion. All interviews were recorded and later transcribed verbatim and organized into data files. This step was followed by a read through of the data and initial coding. The data was then divided into themes through a process of coding called categorical aggregation (Creswell, 2007). Naturalistic generalizations were drawn at the conclusion of the data analysis in an effort to determine students' perspectives, particularly African-Americans, of culturally relevant instruction. The analysis of the study resulted in six themes: 1) home-like classrooms; 2) ethic of caring; 3) participation opportunities; 4) technology use; 5) confidence; and 6) motivation.

Motivation

The three articles are a result of my curiosity to know more about CRP and the effect it has on African-American students learning of mathematics. A number of researchers suggest it as a possible solution to enhancing mathematics education for students of color (African-Americans and Hispanics) without providing evidence of effectiveness, but I desired to see evidence (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard, Brooks, Barnes-Johnson, & Berry, 2010; Tate, 1995). Therefore, the meta-synthesis (Chapter II) was a search for already published evidence, and Chapters III and IV were designed to produce new evidence of the effect of CRP. The overall purpose of this study is to convince the reader that instructional strategies such as CRP are pertinent for enhancing mathematics education for African-American students.

CHAPTER II

NURTURING MATHEMATICAL BRILLIANCE IN AFRICAN-AMERICAN STUDENTS: A META-SYNTHESIS OF CULTURALLY RELEVANT MATHEMATICS TEACHING

The “achievement gap” is a popular term commonly used when discussing mathematics education of minority and/or economically-disadvantaged students (Gutiérrez, 2008; Ladson-Billings, 2006). It “refers to the disparities in standardized test scores between Black and White, Latina/o and White, or recent immigrant and White students”(Ladson-Billings, 2006, p.3). Gutiérrez discussed the dangers of “gap-gazing” which is a term she used to describe research that focused on the “achievement gap.” The main flaw is that examining the gaps fails to demonstrate the history and/or the context of why such gaps exist (Gutiérrez, 2008). In addition, Gutiérrez (2008) described dangers encountered from “gap-gazing”: 1) supporting deficit thinking and negative stories of students of color; 2) perpetuating the myth that the problem and solution is technical; 3) promoting a narrow definition of learning and equity; and 4) providing an unchanging view of inequities. Due to these dangers, it should be avoided when used in defense of Black children in mathematics education (Gholson et al., 2012).

Different from gap-gazing, mathematics educators interested in the education of Black children should consider the brilliance of Black children as axiomatic versus that of a conjecture (Gholson et al., 2012). Martin defined a conjecture as “a proposition that is unproven but is thought to be true but has not been disproven,” whereas an axiom is “a logical statement that is assumed to be true . . ." without need for a proof (Gholson, Bullock, & Alexander, 2012, p. 2). In viewing the brilliance of Black children as axiomatic, researchers no longer have to prove that Black children are brilliant, but use the fact that Black children are brilliant as a starting point for their research. Gholson et al. (2012) stated that "Black children as an axiom seriously disrupted our sense of doing the work of mathematics education research related to Black children" (p. 2). I, as a researcher in this study, concur with their feelings because this axiom also caused alterations in my thought patterns related to the conduct of this research.

Before hearing about the axiom of the brilliance of Black children, I desired to document the existence of the achievement gap in order to say "Houston, we have a problem"! I wondered how to describe the necessity of researching African-American students in mathematics without addressing the issue of their performance in relation to other students. The instance in time when my perceptions changed was during the Benjamin Banneker Association conference in Atlanta (2011) while listening to a presentation given by Dr. Martin. That message led me to think deeply about the axiom and how it related to my research. Therefore, I today understand how "gap-gazing" lends itself to the negative theories and stories of students of color, and that research related to African-American students in mathematics education should be more optimistic. Therefore, the present study does not contribute to the literature on "gap-gazing".

As an African-American female, I definitely agree that Black children are brilliant. African-American students have "immeasurable talents and innumerable strengths" (Ladson-Billings, 1997, p. 707). I experience the brilliance of Black children in my daily life. These experiences include seeing them in my family, working with them in the community and at church, and teaching them as an educator. Although Black children are brilliant, Black children do not always demonstrate their brilliance in the classroom (Jackson, 2012). The lack of demonstration could be due to fear (Witherspoon, Speight, & Thomas, 1997), lack of confidence (Jackson, 2005), comfort zone (Hutchinson, 2009), lack of support (Huff et al., 2005; Steinberg, Dornbusch, & Brown, 1992), lack of caring teachers (Polite, 1993), lack of equitable classrooms (Malloy & Malloy, 1998), or a number of other reasons. Black children sometimes need their brilliance to be directed or structured, or simply need to be guided in how to exemplify their brilliance. African-American students have the potential for high intellectual achievement who desire to reach this potential (Jackson, 2005).

Pedagogies in Mathematics Classrooms That Nurture the Brilliance of Black Children

Placing African-American students in supportive learning environments is one aspect of education that can nurture the brilliance of African-American students. As Jackson (2005) described:

> "They [African-American students] sit in classrooms waiting for the opportunities that can elicit their attention, creativity, and potential. But misperceptions about race and a lack of teacher knowledge on how to elicit and nurture their potential keeps them waiting." (p. 203)

As a result while African-American students wait, their skills atrophy making the acquisition of future skills more difficult. A supportive learning and caring environment advances African-American students' cultural identities and encourages high academic performance (La Vonne, McCray, Webb-Johnson, & Bridgest, 2003). In addition, small supportive learning environments enhance African-American students learning opportunities (Cooper, 1996). Croom (1997) argued that all students can learn challenging mathematics when placed in equitable learning environments which helps engage students to become active participants. Therefore, one way of nurturing the brilliance of African-American students is by placing them in an appropriately supportive environment.

Pedagogical Strategies

Creating supportive learning environments to nurture the brilliance of Black children in mathematics includes, not exclusively, examining topics such as high quality curriculum materials, professional development, pedagogical strategies, and assessment (Allexsaht-Snider & Hart, 2001; Schoenfeld, 2002). The current study focuses solely on the pedagogical strategies that nurture the brilliance of Black children. Watkins and Mortimore (1999) argued that a common definition of pedagogy is "the science of teaching," but they developed a more inclusive definition, defining pedagogy as "any conscious activity by one person designed to enhance learning in another" (p. 3). Therefore, pedagogy is defined in such a way that its purpose is to enhance learning in individuals. Pedagogy must adapt in order to keep up with the new developments in life which are changing at a rapid pace (e.g. technology), and it must seek to engage those who would otherwise be excluded (Watkins & Mortimore, 1999). The researcher agrees with Ladson-Billings (1997) when she stated, "it is with changed notions of pedagogy that I believe we have the best opportunity for changing the achievement levels of African American students" (p. 701).

Cultural Pedagogy

Many scholars argued that pedagogy in the mathematics classroom is divorced from the everyday experiences of African-American students, and serves as a major obstacle to providing them with an empowering mathematical experience (Ladson-Billings, 1997; Tate, 1994). Tate (1994) argued that African-American students should be offered a pedagogy that is built on their experiences, culture, and traditions. Focusing on students' culture provides opportunities for African-American students' strengths to blossom, confidence to build, and achievement to soar (Jackson, 2005). Including culture in the learning environment also offers African-American students more equitable opportunities to succeed academically and learn meaningfully (Howard, 2001; Malloy & Malloy, 1998). The culture of African-American students can be used in a mathematics classroom by exemplifying role models from African-American students' communities, allowing them opportunities to see students like themselves in textbooks and on classroom displays, and talking about traditions and symbols of their ethnic culture (Malloy & Malloy, 1998). Pedagogy that includes students' culture nurtures the brilliance of Black children. The next three paragraphs provide contextual examples of instances where cultural pedagogy was used to enhance mathematics education for African-American students.

Mathematics classrooms were studied at an African-centered elementary charter school that used Afrocentric teaching methods (Clarkson & Johnstone, 2011). The study was an attempt to guide African-American students toward academic excellence and turn around a failing mathematics program. The Afrocentric teaching methods involved using African cultural precepts, processes, laws, and experiences (Clarkson & Johnstone, 2011). For example, the educators looked to the children for their mathematics input and were able to use cultural concepts such as hair braiding to teach shapes, lines, and patterns. The educators also used historical African concepts in their instructional practices such as kuumba (creativity) and ujima (collective work and responsibility). Engaging students in African-centered instruction provided a blooming foundation for mathematics achievement for African-American students. Student success was measured by comparing the state testing results of African-American students in the state as a whole to the students at the African-centered charter school before and after the research was conducted. Statistically significant improvements were shown through the data. Providing these students with an African-centered education in their mathematics classroom formed a community of practice that provided opportunities of engagement, interaction, and learning, which helped contribute to the success of the African-American students in mathematics.

To develop an understanding of the right triangle theorem, geometry students were engaged in Afrocentric instruction to investigate whether this method would help students understand the concept (Jabulani, 2008). Students were randomly placed in two groups in which one group received instruction about the right triangle theorem using an Afrocentric approach, and the other group received instruction using a Eurocentric approach. The Eurocentric approach emphasized that Pythagoras, a Greek, was responsible for the Pythagorean Theorem, while the Afrocentric approach emphasized that the Pythagorean Theorem is of African origin and predates back thousands of years. All instruction was presented in a video format. African-American, White, and Asian students participated in the study. Only post-tests were used to compare the group means for each ethnicity to the treatment and control group. Student results were higher for all ethnicities of those students receiving instruction using the Afrocentric approach and were statistically significant. Hence, using cultural references in teaching mathematics helped to improve mathematics performance for African-American and White students in this case.

Mathematics concepts rooted in African-American culture were used to engage African-American students in mathematics homework assignments (Powell-Mikle & Patton, 2004). The researchers provided fourth graders with Freedom Quilt Fun Packs as homework assignments that provided:1) hands-on activities and inquiry-based learning; 2) children's literature and informative books to promote parent-child engagement; 3) a family journal to promote home-to-school communication; and 4) ideas for extending the activities. Parents and students learned about the African-American quilt as it was once utilized to help slaves flee plantations and escape to freedom. They also learned about the contributions that African-American women quilters made to American folk art. The freedom quilts provided an opportunity to connect history, mathematics, and families to enhance mathematical learning. Students learned mathematical concepts such as spatial reasoning and relations by drawing maps from their school to home. Family journals and informal teacher interviews with students were used to determine effectiveness of the homework assignments. The homework assignments involving the Freedom Quilt Fun Packs resulted in student engagement, family participation, connections to home culture, and students describing learning as “having fun.”

Each of these studies provided evidence that using cultural aspects of African-American students in the pedagogical strategies of mathematics will enhance mathematical learning and performance. Using cultural artifacts such as the Freedom Quilt Fun Packs, historical African mathematicians, and Afrocentric videos helped to contribute to the mathematical achievement of African-American students.

Origins of Social Justice Pedagogy

Social justice pedagogy was developed through the work of Gutstein (2006) while he was teaching mathematics in a predominantly Mexican and Mexican American community. Social justice pedagogy is situated in Freire’s work of the pedagogy of the oppressed, culturally relevant pedagogy, and African-American liberatory education. African-American liberatory education is designed to liberate the oppressed by making them aware of the conditions that allowed the oppression. The main purpose of teaching for social justice is liberation from oppression (Gutstein, 2006). It has three main goals that include helping students develop socio-political consciousness, sense of agency, and positive social and cultural identities (Gutstein, 2003). Teaching mathematics for social justice provides an opportunity for students to begin to read the world with mathematics, develop mathematical power, and change their dispositions toward mathematics (Gutstein, 2003).It can help students of diverse backgrounds use mathematics for political, social, and economic empowerment (Esposito & Swain, 2009; Leonard et al., 2010). In order to contextualize social justice pedagogy, two studies were reviewed to help the reader compartmentalize what social justice pedagogy comprises in the mathematics classroom.

Social justice pedagogy (SJP) was implemented for three weeks in an urban school environment (Bacon, 2012). Topics related to the fairness, equity, and environment of the classroom were covered in an Algebra II course during lessons on exponents and polynomials. Critical to the implementation was the creation of a community of problem solvers by using higher-order thinking questions that resulted in students practicing equity and fairness with others through the process of learning to critique peers' reasoning. In addition, word problems were used to talk about social justice topics. Pre- and post-test for the mathematics content affect were given to students to determine their conceptions about social justice and mathematics in their lives. Results from the content pre- and post-tests showed statistically significant improvements using *t*-test, but the results from the affective surveys did not produce statistically significant results. Therefore, the social justice pedagogy improved mathematics performance of students from urban school settings while holding affect constant. Further research was suggested, especially for determining changes in student attitudes after participating in SJP (Bacon, 2012).

A Chicago school district opened a new school in a predominantly Latino neighborhood, but redrew the inclusion boundaries to include African-American students from a nearby neighborhood. Latino politicians and parents wanted the boundaries to be redrawn to exclude the African-American students. The mathematics team at the newly opened school engaged African-American and Latino ninth-grade students in a social justice mathematics project that involved determining a fair solution to the problem of having one new school with too many students from two different communities (Gutstein, 2012). Students learned about probability as they observed census tract data and calculated acceptance probabilities for both communities. Students also had to consider ways in which the boundaries could be redrawn that would allow students from both communities to have the same acceptance rate. Through this social justice project, the mathematics team was able to build on students' community knowledge, and students developed critical and classical mathematical knowledge (Gutstein, 2012). Based on results from focus groups, students expressed support and interest in the issues being discussed in the project leading to a continuation with future classes on issues of displacement and capitalism.

Bacon's (2012) and Gutstein's (2012) work provided examples of African-American students benefiting from SJP. In Gutstein's (2012) research, Latino students also benefited from SJP. Social justice pedagogy can indirectly apply to cultural pedagogy because as students are learning about social justice issues in society, they are also learning about issues that exist within their communities such as in Gutstein's (2012) research.

Origins of Culturally Relevant Pedagogy

Culturally relevant pedagogy (CRP) employs both cultural and social justice pedagogies. Ladson-Billings (2009) conducted an ethnography with highly effective teachers of African-American students to document their practices. In the process of Ladson-Billing's study, she developed a grounded theory from the observed commonalities of practice by the successful teachers which she termed "culturally relevant pedagogy" (1995d). Ladson-Billings (1995d) defined CRP as "a theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (p. 469). She (1995d) developed the theory of CRP to satisfy three principles: 1) develop students academically; 2) nurture and support cultural competence; and 3) develop sociopolitical and critical consciousness.

Academic success in mathematics among African-American students can be promoted through the use of classroom instruction aimed at rigorous mathematical learning goals (Jackson & Wilson, 2012). Jackson and Wilson (2012) theorized that if students participate in classroom activity aimed at rigorous learning goals, then they are more likely to develop lasting understandings of mathematics, and thus have a higher chance of achieving academically. Since President George W. Bush passed the *No Child Left Behind Act* (2001), standardized testing has been intensified and is the accountability measure of academic achievement for education in the United States (Kober, 2010; Marshak, 2003). Therefore, CRP should develop students who can achieve on standardized tests (Ladson-Billings, 1995d). As Ladson-Billings (1995d) stated, "no theory of pedagogy can escape this reality" (p. 475). Standardized testing has served to characterize and rank schools and individuals, and as a result students must demonstrate an ability to achieve in literacy and numeracy (Ladson-Billings, 1995d). Students have to be able to "read, write, speak, compute, pose and solve problems at sophisticated levels" (Ladson-Billings, 1995d, p. 475). Although, standardized testing is the main measure of academic achievement, scholars have encouraged authentic forms of measurements as well (Kim & Sunderman, 2005; Ladson-billings, 1995d). Hence, African-American students should be prepared to achieve academically on standardized testing and beyond.

Culturally relevant pedagogy provides a way for African-American students to maintain their cultural integrity while succeeding academically (Ladson-Billings, 1995d). Deep cultural analyses revealed common characteristics of African-American culture. For instance, Boykin (1994) described nine dimensions of Afro-Cultural expressions present in the lives of African-Americans: spirituality, harmony, movement, verve, affect, expressive individualism, communalism, orality, and social time perspective. The deep structure of African-American culture is rooted in affinity for rhythm and pattern (Ladson-Billings, 1997). This is illustrated in African-Americans' love for jazz, gospel music, rap, poetry, basketball, sermonizing, dance, and fashion (Ladson-Billings, 1997). There are many more cultural values and styles of African-American students, but they are all to be appreciated and affirmed in order to provide a supportive environment for maintaining cultural integrity while still succeeding academically (Chideya, 1995; Mahiri, 1998).

Culturally relevant pedagogy embodies a sociopolitical teaching approach in an effort to nurture the growth of moral and productive citizens in a democratic society. It involves teaching with a worldview in mind (Leonard et al., 2010). The teachers are required to integrate social justice and political issues within the classroom that current curriculum refuses to deal with, such as racism, historical atrocities, powerlessness, and poverty (Gay, 2002). Sociopolitical teaching challenges students to critique society, and to seek solutions (Tate, 1995). It offers opportunities for students to learn mathematics in a way that is meaningful to their lives, and helps them to develop positive mathematical identities that are necessary in achieving mathematical success (Leonard et al., 2010). In order for teachers to implement social justice curriculum, they must be knowledgeable and understand the cultural, social, political, and economic inequities that affect the lives of African-American students (Leonard et al., 2010). Therefore, CRP should be used to help students recognize, understand, and critique current social inequities (Ladson-Billings, 1995a).

Teachers are the central figures for changing pedagogy because they are the implementers (Kelly, 2004; Pinar, 2004). Therefore, a teacher who chooses to implement CRP must assimilate in their belief structures three theoretical underpinnings: (1) conceptions of self and others, (2) social relations, and (3) conceptions of knowledge (Ladson-Billings, 1995d). Teachers with positive conceptions of self and others believe that all students are capable of academic success, view themselves as members of the community, and view teaching as a way of giving back to the community (Ladson-Billings, 1995d). Teachers who use CRP maintain positive social relations forge fluid student-teacher relationships, demonstrate a connectedness with all students, and develop communities of learners (Ladson-Billings, 1995d). Another common factor among teachers who use CRP is that they are passionate about knowledge and learning, and their conceptions of knowledge include: 1) knowledge must be viewed critically; 2) knowledge is shared, recycled, and constructed; and, 3) scaffolding must be used to facilitate learning (Ladson-Billings, 1995d). In order to successfully implement CRP in mathematics classrooms, the teacher has to nurture positive beliefs surrounding these three theoretical underpinnings (Ladson-Billings, 1995d).

Purpose of Research

Scholars recommend culturally relevant pedagogy, not as a cure-all, but as one means to enhancing mathematics achievement among African-American students (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard et al., 2010; Tate, 1995). But, “there are very few studies of culturally relevant mathematics teaching in contexts with predominantly African-American students that focus on the nature of interactions that support (or do not support) African-American youth to achieve particular goals” (Jackson & Wilson, 2012, p.376). Also, Leonard et al. (2010) asserted that examples of CRP and SJP used together in the mathematics classroom is scarce. Within the few studies available regarding culturally relevant pedagogy, some teachers have reported, “they were no better able to support their African-American students in mathematics instruction [book studies and culturally relevant pedagogy professional development]” (Jackson & Wilson, 2012, p. 356). These arguments demonstrate the need for more research on CRP and the mathematics achievement of African-American students.

Culturally relevant pedagogy has received growing interest in educational contexts for African-American students, and because many scholars suggest its use, I particularly find Jackson and Wilson's (2012) quotation hard to believe. Therefore, the goal is to conduct a meta-synthesis to determine the effectiveness of CRP on the mathematics achievement of African-American students. This goal is accomplished by addressing the following research questions: 1) What student results have been produced from prior culturally-relevant mathematics research for African-Americans?; and 2)How has CRP been used as a source of empowerment for mathematical learning among African-American students?

Defining Empowerment

Empowerment is a broad term widely utilized but underspecified. For example, Strutchens (2000) discussed issues that impeded mathematical empowerment for African-American students but did not define empowerment once. Obiakor and Beachum (2005) did not explicitly define empowerment but utilized empowerment in the context of the characteristics that foster the growth of academic achievement for African-American students. Hence, empowerment in this study is the characteristics that enable African-American students to achieve mathematically. In trying to make sense of empowerment, I brainstormed aspects of African-American students that have the potential to foster their academic growth. The deliberation produced the following characteristics: attitude, anxiety, confidence, behavior, engagement, self-efficacy, and self-identity. A Google Scholar search was then conducted to determine the number of results that would be returned from each characteristic along with culturally relevant mathematics pedagogy. The Google Scholar search contained the words "culturally relevant pedagogy" AND "mathematics" along with each characteristic one at a time. The results of the search are displayed in figure 1.

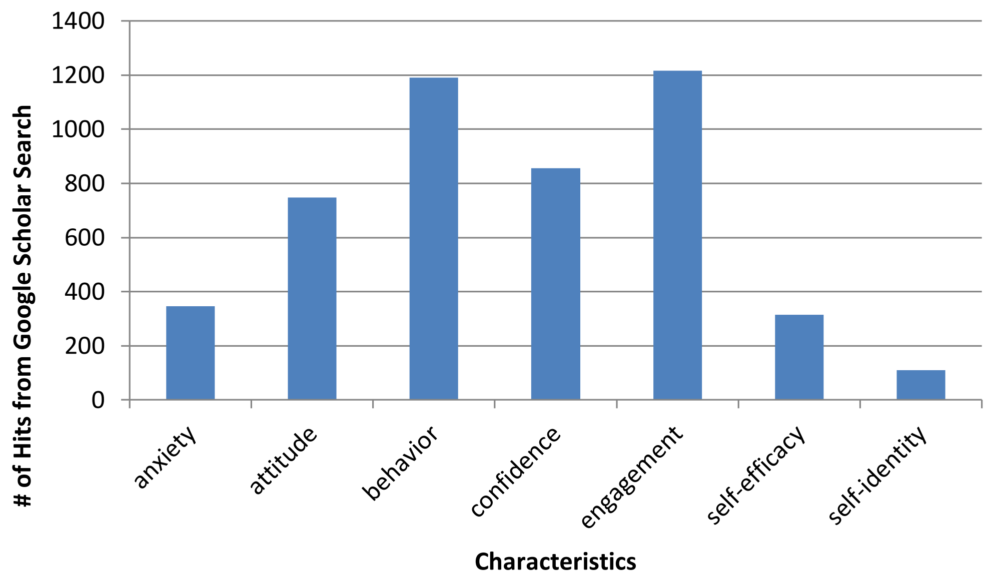

Figure 1. Google scholar results of the characteristics of empowerment for African-American students.

Behavior and engagement resulted in the greatest number of hits, followed by confidence and attitude, respectively. Therefore, while searching for ways CRP is used to empower African-American students, I looked for characteristics of African-American students that help them to learn mathematics, especially outcomes related to engagement, behavior, confidence, and attitude.

Methodology

Meta-Synthesis

A meta-synthesis is an explanatory model used to describe the findings of similar qualitative studies (Walsh & Downe, 2005). The purpose of the meta-synthesis is to try to understand and explain the phenomena of interest (Walsh & Downe, 2005). A meta-synthesis is a parallel technique to a meta-analysis, but a meta-analysis is different because it examines quantitative work and the purpose of it is to increase certainty in cause-and-effect conclusions in an area of interest (Glass, 1976).A meta-synthesis is commonly used in the field of nursing science because that field has experienced a surge in qualitative research (Jensen & Allen, 1996).

I was interested in understanding and explaining the phenomena of interest and in increasing certainty in cause-and-effect relationships, but there was not a sufficient amount of quantitative literature found related to mathematics CRP and African-American students. Therefore, I chose to conduct a meta-synthesis to try to understand this relationship. A framework to construct and interpret a meta-synthesis was presented by Jensen and Allen (1996), and was followed in the present study. The steps for conducting the meta-synthesis include data retrieval and the establishing of criteria for the selection of data. The plan for interpreting includes: 1) the texts are compared in a holistic fashion; 2) the findings are standardized via common codes, outlines, and reporting formats; 3) relationships are developed between studies by using metaphors, phrases, concepts, ideas, and categories to create themes; 4) the studies are translated into one another; and 5) the translations are synthesized to lead to a description of the phenomena.

Search Strategy

The first phase of the meta-synthesis involved a search for literature addressing student outcomes after participating in culturally relevant mathematics pedagogy. Three search databases were used to find the literature: 1) Educational Resource Information Center (ERIC); 2) Education Full Text; and, 3) Google Scholar. The first step involved a search in the ERIC database using the Boolean phrase "culturally relevant pedagogy" AND "math* achievement". The asterisk (*) was used along with the word math so that all forms of the word would be returned in the search, for example "mathematical" and "mathematics". Because Ladson-Billings published the article defining culturally relevant pedagogy in 1995, the limiters included the years of publication to be between 1995 and 2012. The search resulted in 41 hits. In addition, a search in Education Full Text with the exact same Boolean phrase and limiters produced three additional documents. Then a Google scholar search with the words "culturally relevant pedagogy" AND "mathematics achievement" was conducted and resulted in 303 hits in which five were duplicates. Therefore, the first round search resulted in a total of 342 hits of literature related to CRP and mathematics achievement from the three databases used.

As mentioned previously, a common definition of pedagogy is "the science of teaching." Therefore, in an effort to capture all literature related to culturally relevant pedagogy and mathematics achievement, the Boolean phrase "culturally relevant teaching" was used along with the phrase "math* achievement" in the second round search, instead of "culturally relevant pedagogy", with the years of publication limited between 1995 and 2012 in ERIC and Education Full Text. ERIC resulted in two hits in which both of the hits were duplicates. Education Full text resulted in one hit, and it was also a duplicate hit. In the Google scholar database the second time around, the Boolean phrase "culturally relevant teaching" AND "mathematics achievement" with the years of publication limited between 1995 and 2012 were used. This time Google Scholar produced 150 hits, and 77 of the hits were duplicates. Thus, the second round search produced an additional 73 hits to be added to the list of literature related to culturally relevant pedagogy and mathematics achievement. The search for literature from the three databases using the two different Boolean phrases returned 415 hits.

The search did not use the terms "culturally appropriate", "culturally responsive", "culturally congruent", and "culturally compatible" because Ladson-Billings (1995d) defined culturally relevant pedagogy as distinct from these terms. She (1995d) discussed how "culturally appropriate", "culturally congruent", "culturally responsive", and "culturally compatible" have commonalities such as: 1) they locate the source of student failure and successive achievement within the speech and language interactions between teacher and student; and 2) they suggest that student success is represented in achievement in social structures that exist in schools (Ladson-Billings, 1995d). The important difference between the other terms and CRP is that CRP extended those concepts to include analysis of inequities for students to: 1) recognize, analyze, and critique those inequities; and 2) problem solve ways to change the inequities and make a difference.

The next phase of the search involved reading through the abstracts of each of the 415 hits to find literature that met the criteria established for inclusion in the meta-synthesis: 1) engage students in culturally relevant mathematics pedagogy, and 2) report student impact or outcomes for African-American students. The 415 hits included books, conference papers, journal articles, dissertations, theses, policy papers, and reports. A list of the 415 documents was composed and printed, and each hit was coded with a "yes", "no", or "maybe". The "yes" represented the documents that clearly met both criteria in the abstract. The "maybe" represented the documents where the abstract met one criterion but did not have enough information to determine if the other criterion was met. The documents coded with "no" were those documents that clearly violated one or both of the criteria within the abstract. The process of reading through the abstracts resulted in six documents coded "yes" and six documents coded "maybe". Many of the documents were eliminated for various reasons, such as: 1) the content was not mathematics (Boutte, Kelly-Jackson, & Johnson, 2010; Brayboy & Castagno, 2009; Deason, 2011); 2) teacher and implementation focused (Averill et al., 2009; Garcia et al., 2010, Lipman, 1996; Matthews, 2008; Moore, 2012); 3) targeted other ethnicities (Gutstein et al., 1997; Molefe, 2004), just to name a few. Therefore, 12 (six coded "yes" and six coded "maybe") of the 415 hits were selected to be considered for further review.

Finally, full-text copies of the 12 documents related to culturally relevant pedagogy and African-American students' mathematics achievement were obtained to conduct a more in depth review of the "maybe" group (Cave, 2008; Gay, 2002; Jabulani, 2008; McClain & Berry III, 2009; Powell-Mikle & Patton, 2004; Terry, 2010) to ensure they met the criteria. The abstracts were reread along with the purpose of research statements to determine if the documents met the requirements to be included in the meta-synthesis. Four of the "maybe" documents were eliminated because they were determined to have violated criterion one (Cave, 2008; Gay, 2002; Jabulani, 2008; Terry, 2010), and one document was eliminated because it violated criterion two (Powell-Mikle & Patton, 2004). One of the "maybe" documents (McClain & Berry III, 2009) was recoded as "yes". Therefore, seven documents (three dissertations, three peer-reviewed articles, and one conference proceeding) made the final cut to be included in the meta-synthesis.

In order to obtain a better picture of the findings, it is necessary to first review the context of each study. Table 2 provides a general overview of each study, including the sample, mathematics content, and overall results, but below is a more in-depth description of each study.

Table 2

Matrix of Demographics, Effect on Student Outcomes, and Content by Article

Author	Sample	Mathematics Content	Outcomes
Cross et al.	16 African-American girls	Statistics	+ Knowledge HSL (+ Metacognition) +21st Century Skills (Life Skills) + Engagement + Motivation + Community Advocacy MA (+ Conceptual Understanding)
Enyedy & Mukhopadhyay	25 African-American and Latino Students	Statistics	+ Knowledge + Motivation + Engagement + Life Skills + Community Advocacy MA (+ Statistical reasoning)
Hobbs	90 Algebra I students (62 African-American)	Algebra I	- Usefulness - Attitude MA (+ NAEP scores; - CDROM: *Riding the Freedom Train*)
Langlie	6738 10th grade students (809 African-American)	Unspecified	+ MA
Leonard, Davis, & Sidler	73 African-American Students	Fourth grade mathematics	+ Engagement + MA (*Riding the Freedom Train*) HSL (+ Desire for students to create new knowledge; + Student inquiry) + General Knowledge + Fun and excitement
McClain & Berry III	100 middle school students (63 African-American)	Adding integers	+ MA + Engagement + Life Skills

Table 2 Continued

Author	Sample	Mathematics Content	Outcomes
Walker	66 Average Nine Year Olds (61 African-American)	Unspecified	HSL (+ Turn in Homework Assignments) + Life Skills + General Knowledge MA (+ Homework Grades; - WRAT)

+ signifies an increase and – signifies a decrease; HSL = Habits of Student Learning; MA = Mathematics Achievement

Description of the Selected Documents

Thirteen African-American girls were engaged in a summer camp in which the Cross et al. (2012) titled the activities project-based learning. The instructors of the summer camp had students read an article about students performing better on standardized tests when they ate breakfast before testing. The students then had to draw conclusions based on the statistics presented in the article, in which they concluded that eating breakfast before taking exams leads to better test performance. The students were then prompted to come up with a solution to help students do better on standardized tests at their school. The students decided that if the school served breakfast that people actually like, then more people would eat breakfast. Students then created a survey of four breakfast options and gave the surveys to their classmates. Students learned about the statistical process, and analyzed the data by calculating measures of central tendency and dispersion. Students also created representations of the data, and presented their findings to school administrators. All students in this study participated in a pre- and post-interview, and all of the classroom sessions were videotaped. The data from the interviews and the classroom sessions were used to answer the research questions of the study. Although the authors labeled their study as project-based learning, after reading the article and the context of the intervention, the study actually engages students in culturally relevant pedagogy.

High school students were engaged in a five week summer seminar at UCLA which was in honor of the 50th anniversary of Brown versus Board of Education (Enyedy & Mukhopadhyay, 2007). Students studied the changing demographics of Los Angeles schools, the shift in policies around integration, and the struggles that the communities faced in trying to reach the promise of equal education. For the mathematics portion of the program, students used geographic information systems (GIS) in order to examine the demographics and the average incomes of communities in Los Angeles. Students then examined the demographics of the schools in the various communities, and they were able to conclude that most of the predominantly minority schools were located in low-income areas whereas schools with low populations of minority students were located in wealthy neighborhoods. Students learned how to use qualitative and quantitative data to make claims. Students in this study took a pre- and post-assessment and presented a final oral presentation. Each learning session was also video-taped and the data were used for analyses.

Ninth-grade students were immersed in a culturally relevant activity that involved the use of a computer software program titled *Riding the Freedom Train* developed by Jacqueline Leonard (Hobbs, 2010). Control groups were used to compare the results of students that participated in the culturally relevant task. There were five

Algebra classes involved in the study, two control and three treatment groups. The five groups participated in one of two studies. Study one was a pilot study that Hobbs used to test the instruments before conducting Study two. Study one had one control and two treatment groups, and study two had one control and one treatment group. The treatment group worked in the computer lab using the computer software program for a period of eight weeks. The treatment group was also exposed to word problems that were based on cultural themes. The control group was taught mathematics using the traditional methods of teaching, and they had exposure to neither the computer lab nor the culturally specific word problems. The computer software provided a Google maps project in which students were prompted to locate points on a coordinate system within their neighborhood. Students then had to measure the distance from those points to their school on a weekly basis. Students also were responsible for plotting the points, graphing the line passing through the points, finding the slope of the line, and measuring the distance between two points. Students in this study took two assessments. The first assessment was created by the researcher in which he took problems from prior National Assessment of Educational Progress (NAEP) mathematics assessments. The second assessment was part of the computer software program that was being used for the treatment group. Students also took a pre- and post-mathematics attitude survey.

Not all studies took the same approach. The effect of CRP was measured differently in Langlie's (2008) study. Instead of actually taking a group of students and engaging them in CRP, Langlie (2008) gave students, teachers, and administrators' questionnaires in order to determine which teachers actually used CRP in their everyday teaching. The student questionnaires were about cognitive growth, school practices, school effectiveness, and parent and community involvement. The principal questionnaires were about general school characteristics, student characteristics, teacher staff characteristics, school admission policies, grades, programs, facilities information, school culture, and behavior climate. The teacher questionnaires were given to the students' mathematics teachers and contained items about teachers' assessment of students, school related behavior and performance, education and career, mathematics content, and school climate and organization. Based on the results from the questionnaires, the researcher determined which teachers actually use culturally relevant mathematics pedagogy. The researcher then analyzed the results of the mathematics cognitive test administered by the state for all of the students of the selected teachers.

Fourth grade students were engaged in a computer assisted culturally relevant activity (Leonard et al., 2005). In this study, students used computer software titled *Riding the Freedom Train*. This was the same software used in Hobbs' (2010) study, but according to the descriptions it involved a different context. The context in this study involved a slave named Sam who decided to leave the Maryland plantation and travel on the Underground Railroad to freedom in Philadelphia. Pictures were used along with the narrative to teach students' science and mathematics concepts related to the story. Students were quizzed throughout the story over 32 problems in which half were science and the other half mathematics related. The authors provided an example of a science question about the Big Dipper star pattern and how it was used by Sam to determine which way was north. Students also took a paper and pencil pre-test. Video recordings of the sessions, student and teacher interviews, and student work samples were also used as data to answer the research questions of the study.

One hundred middle school students were studied in the mathematics classes of two teachers in which one of the teachers used CRP and the other teacher used traditional methods of teaching (McClain & Berry, 2009). The teacher that used CRP incorporated students' culture and lived experiences and also provided a highly demanding, structured, and disciplined environment. The CRP teacher also felt it was very important to understand her students, their backgrounds and their struggles in order to use this information to help them succeed. The teacher that utilized traditional methods of teaching made sure she was both emotionally and physically disconnected from her students. The traditional teacher also focused on providing students with her procedures and techniques to solve problems, and was not open to other methods that students desired to utilize. Students took a pre- and post-assessment that consisted of both multiple choice and open-ended mathematics questions.

Sixty-six at-risk students ranging from third to fifth grade were engaged in a study that employed culturally relevant strategies (Walker, 2009). Students were randomly assigned to either the experiment or control group. The experiment group consisted of ethnocentric pedagogy, and the control group consisted of traditional pedagogy. In each group, students rotated through three one-hour sessions in which each session consisted of: 1) hands-on mathematics; 2) life skills training; and 3) online tutoring with Assessment and Learning in Knowledge Spaces (ALEKS), a web-based online mathematics-tutoring program. The intervention lasted a total of six weeks. In the experimental group, the classroom was rearranged in a way that did not reflect the traditional classroom, but created a sense of community. The instructional practices involved using references that were taken from the students' interests and experiences. Also, there was consistent interaction and communication between the student, teacher, and community. The instructors did not use just a lecture format, but they were facilitators who guided the students in constructing their own learning. The lessons were designed such that they illustrated the importance of mathematics in the everyday lives of the students, and the lessons reflected African or Hispanic cultural traditions and values. Instruction in the control group emphasized individuality and competition, and emphasized famous contributions of European mathematicians. All students completed two surveys, one measured their attitude toward online tutoring and learning, and the other measured their cultural identity. The students' mathematics achievement was measured by ALEKS and a standardized assessment called the Wide Range Achievement Test (WRAT).

Findings

I was specifically looking for empowerment characteristics of attitude, behavior, confidence, and engagement, while also looking for common themes throughout the seven documents. None of the seven documents reported on any behavior or confidence-related outcomes of the students participating in CRP, but they did comment on the other two characteristics. The themes of mathematics achievement, life skills, habits of student learning, community advocacy, and general knowledge were common throughout the documents. The findings on each of these topics are presented.

Attitudes toward Mathematics

The Hobbs' (2010) study is the only one that employed an instrument to measure students' attitude and discussed how it relates to CRP. Hobbs (2010) gave the students in his study a pre- and post-mathematics attitude survey to determine the effects of culturally relevant mathematics instruction on students' attitudes. The findings of his first study revealed that students in one of the treatment groups had more favorable attitudes towards mathematics than students from the other two groups. The findings of Hobbs' (2010) second study demonstrated that students in both treatment and control groups' mathematical attitudes did not change over time. Hobbs (2010) described how he was surprised at these results because he was always getting great feedback from the students, and based on observations their attitudes about mathematics were getting better over time. He provided examples of comments he heard from the students such as "I'm more relaxed and I don't feel like everyone is watching me when I'm in here [computer lab]", and "I can work at my own pace" (Hobbs, 2010, p.70).

Engagement in Learning

The majority of the studies (four out of seven) declared students participating in CRP became more engaged. None of the studies employed an instrument that measured engagement, and all results were reported based on qualitative observations. Enyedy and Mukhopadhyay's (2007) study was successful at creating an environment to motivate and engage students in personally and socially relevant ways. McClain and Berry (2009) also reported that students were more engaged in the culturally relevant classroom than in the traditional classroom. Leonard et al. (2005) discovered that students enjoyed the story line behind their culturally relevant computer software program because the story depicted characters that look like them. Students also self-reported that the intervention was fun and exciting. Leonard et al. (2005) recognized that the culturally relevant mathematics intervention engaged the students at high levels. In Cross et al. (2012), both students' motivation and engagement levels were increased. Those researchers attributed the increase to students dealing with problems relevant to their lives. Students were also engaged because the study provided an opportunity for them to develop a sense of ownership by creating a solution to the problem at hand. The researchers of that study also argued that students were engaged in the activities that used social and political issues relevant to the African-American community. From the results of these four studies, African-American students participating in mathematics CRP became more engaged in learning.

Life Skills

A majority of the studies (four out of seven) reported that life skills were cultivated while participating in culturally relevant mathematics instruction. Life skills are those characteristics developed that students use in their daily lives and are necessary for being productive citizens. One researcher (i.e. Cross et al., 2012) used the 21st century skills as a framework while others might have but it was not clear from their report. The 21st century skills acquired in Cross et al. (2012) included: 1) working as a team; 2) listening to others communicate their ideas; 3) speaking and expressing themselves clearly; 4) being able to read material; and 5) making effective presentations. Cross et al. (2012) detailed increases in student collaboration and communication abilities. Students in that study also gained knowledge about the work of statisticians. Walker (2009) also documented that students engaged in CRP developed a sense of community in their classroom and cooperation skills. These students mastered working together versus working against each other in a competitive nature. McClain and Berry (2009) mentioned that students were able to share and justify their thinking as well as demonstrate respect of other perspectives in the mathematics class where CRP was utilized. Enyedy and Mukhopadhyay (2007) provided students with ways of reasoning and engaging in public discourse that showed how students can increase their voice and participation in a democratic society. Their study was also successful at helping students make well-articulated claims about equitable educational opportunities in their own city, and how to use quantitative and qualitative evidence to support those claims. In the four studies mentioned, students who participated in CRP to learn mathematics developed life skills to assist them in becoming productive citizens in a democratic society.

Habits of Student Learning

Habits of student learning include those skills that can be transferred and used to improve learning in any type of learning environment regardless of content. Four of the studies documented improvement in student learning habits as a result of participating in CRP. However, none of the studies used instruments to measure students' habits of learning but instead reported from qualitative observations. Enyedy and Mukhopadhyay (2007) discussed how their study taught students technical and scientific practices which are necessary for students in furthering their education, and possibly in employment opportunities. The technical practice included students use of the geographic information system to determine information about the city in which they lived. The scientific practice involved the students making claims and using evidence to back it up. In Walker's study (2009), students were guided in constructing their own learning, which helps students to develop a sense of educational responsibility. Walker (2009) also informed the reader that students in her study participating in CRP returned homework assignments more often than students that participated in traditional pedagogy. Cross et al. (2012) declared that students participating in CRP developed the ability to reflect on their own thinking which in turn enhances their thinking abilities. Leonard et al. (2005) promoted student inquiry and encouraged students to create new knowledge. Students in their study continued to inquire of the story line and wanted to continue moving forward to see how the story would end. Therefore, CRP affords circumstances for students to develop transferrable learning habits.

Community Advocacy

Two of the studies reported aspects of community advocacy as a result of engaging students in CRP. Cross et al. (2012) indicated that students were able to use statistics in an effort to make a change in the world. The students in their study were given the opportunity to present the work they did to the administration of their school as a solution to the low test scores obtained by students on standardized tests. The students in the study advocated for the student body by offering an alternative to the breakfast options the school currently served. Students also used statistics as a tool for community advocacy in Enyedy and Mukhopadhyay's (2007) study. Students were provided a chance to study the changing demographics of Los Angeles schools, the shift in legal policies around integration, and the struggles of the communities to realize the promise of equal education. Their study was orchestrated in a way that the mathematical activities and discussions were motivated by the students' perceptions of the need, relevance, and value of statistical reasoning and data in service of their social justice advocacy. Students presented their research at a public forum to UCLA faculty, civil rights attorneys, and members of their community. When CRP is implemented in such a way that includes all three components of 1) academic excellence, 2) maintaining cultural integrity, and 3) recognizing, analyzing, and critiquing social inequities, it opens doors for students to participate in community advocacy.

General Knowledge

Using CRP as a conduit to teach mathematics gives students the possibility to learn more than mathematics concepts. For instance, the students in Leonard et al. (2005) reported they learned about the Underground Railroad. Some of the students thought the Underground Railroad was an actual railroad. As a result of using *Riding the Freedom Train,* students were able to understand that the Underground Railroad was actually a path that slaves traveled, not underground, in an attempt to move from slave states to free states. The students in Walker's (2009) study claimed they learned new information about the history of African-Americans and Hispanics. These students also gained knowledge of famous African-American and Hispanic mathematicians and their contributions to society. Therefore, exercising CRP for mathematics instruction provides ways for students to gain general knowledge beyond mathematics content.

Mathematics Achievement

All of the studies reported on the mathematics achievement of African-American students after participating in CRP. All of the seven studies detailed an increase in mathematics achievement for these students. McClain and Berry (2009) analyzed pre- and post-tests over mathematics content by an ANCOVA. The results indicated that the method of instruction (CRP) students were exposed to had a statistically significant influence on their mathematics achievement. According to the parameter estimates produced from that study, students in the treatment group had a post-test score 6.5 points higher that the students in the control group. The students in Walker's (2009) study who participated in CRP scored higher on homework assignments than students in traditional pedagogy. Leonard et al. (2005) announced that students' mathematics and science scores improved over the one-month period that the students were engaged in CRP. They only reported on the changes in scores, but did not report the actual scores, means, or standard deviations for the students. Students gained knowledge of statistical terms in Cross et al.'s (2012) study. Students not only learned how to compute statistical measures such as the mean, but they also developed conceptual understandings of the terms. Ninety percent of the students that participated in their study were able to describe data, statistics, and the work of statisticians. Those students also learned about the statistical investigation cycle (i.e. identifying the problem and research question, planning the procedure for data collection, selecting an appropriate sample, collecting data, analyzing data, and drawing conclusions). Enyedy and Mukhopadhyay (2007) analyzed pre- and post-assessments and concluded that there were statistically significant gains of 3.6 on a 16 point scale. Students in their study also developed an ability to link qualitative and quantitative claims to evidence. In addition, the students were able to establish better statistical reasoning skills. Langlie (2008) declared that students engaged in CRP were more likely to achieve in mathematics. Particularly, Langlie's (2008) study found statistically significant results for the interaction of African American and Hispanic students' mathematics achievement with teachers' positive conceptions of self and others which is an aspect of the CRP teacher. Hobbs' (2010) first study reported that one of the treatment groups (CRP) had the greatest increase in scores from pre- to post-test on NAEP assessment. Thus, African-American students participating in these CRP studies experienced increases in mathematics achievement.

Although most of the studies reported favorable results for mathematics achievement of African-American students participating in CRP, a couple of the studies reported some non-favorable results. Walker's (2009) study showed no statistically significant differences from pre- to post-assessment on the WRAT. Also, Hobbs (2010) conducted two different studies that resulted in negative mathematics achievement for African-American students in the treatment groups. The results of Hobbs' (2010) first study revealed a statistically significant decline in the pre- to post-CD Rom scores for students in the treatment group (CRP). Hobbs (2010) concluded the computer-based instruction (CRP) and the assessments involving NAEP questions did not impact students' problem-solving abilities. Also, in the second study conducted by Hobbs (2010) the NAEP assessment scores were higher for the control group than the treatment group. Therefore, not all of the CRP studies produced favorable mathematics achievement.

Discussion

None of the seven documents reported on confidence or behavior factors associated with students after participating in CRP. This suggests that there needs to be more research that explores the relationship between: 1) confidence and CRP; and 2) behavior and CRP. Also, only one study measured the relationship between students' attitudes and CRP. Therefore, more research also needs to be conducted to examine the effect of CRP on student attitude. In one study (Hobbs, 2010) students who participated in CRP had better attitudes toward mathematics than those who did not, but in the other study (Hobbs, 2010) student attitude toward mathematics did not change at all for students who participated in CRP. Hobbs (2010) stated that he was surprised at these results. I was also surprised at the results of students' attitude as it relates to CRP. Student attitude was measured by a mathematics attitude survey, and the researcher expressed a concern that the results of the surveys did not match up with the reality of his observations of teaching the students. Hence, future research should possibly consider measuring student attitude in alternative ways such as using an instrument that measures mathematics attitude as it relates to CRP or qualitative methods of interviewing, classroom observations, or questionnaires.

Teaching students mathematics employing CRP increased student engagement in a majority of the studies. I expected all of the studies to report an increase in engagement, but they all did not. It is possible that the three articles (Hobbs, 2010;

Langlie, 2008; Walker, 2009) that did not document an increase in engagement failed to recognize it because they solely utilized quantitative procedures that did not directly measure engagement. I am not at all implying that using only quantitative methods fails to measure the level of engagement because McClain and Berry (2009) solely utilized quantitative measures and reported results of increased student engagement, but I am suggesting it as a possibility for failing to detect a change in engagement. Some of the studies that reported an increase in engagement attributed it to the link between students' culture and the mathematics instruction. This leads to a suggestion for further research to study cause and effect relationships between CRP and engagement. According to the studies in this meta-synthesis, mathematics CRP increases student engagement in the learning process.

Students who participated in mathematics CRP, in most of the studies, developed life skills to help prepare them for the real-world. Throughout history, the purpose of education was to prepare students to enter society as full participants. If the society was militant, then education was geared towards teaching students how to be successful in combat (Gutek, 1995). Therefore, because CRP assisted students in developing life skills which prepares them to be productive citizens in a democratic society, then CRP supports the purpose of education. Research has documented that CRP helps to prepare students to become active participants in a democratic society but does not expound on how this can be achieved (Gutstein et al., 1997; Ladson-Billings, 1995b, 1995d; Leonard et al., 2010). Analysis of the four studies (Cross et al., 2012; Enyedy & Mukhopadhyay's, 2007; McClain & Berry, 2009; Walker, 2009) illustrates how CRP prepares students for the real-world. Using CRP in a mathematics classroom provides opportunities for students to cultivate certain skills such as communication, collaboration, cooperation, and reasoning which are all necessary for being productive citizens.

Using CRP in a mathematics classroom offered opportunities for students to develop transferrable habits of learning. These habits included taking responsibility for their own learning, increasing their thinking abilities, turning in their homework more frequently, creating new knowledge, and increasing levels of inquiry. It is important to note that students not only gained knowledge of mathematics skills while participating in mathematics CRP, but they also learned skills that they can use to be successful in other classrooms. These skills become habits through practice which means they are used regularly. Thus, students are placed in a win-win situation when engaged in CRP because they are given the opportunity to develop content skills and transferrable habits of learning.

Most of the studies did not use the third component of CRP that deals with helping students to recognize, analyze, and critique social inequities. If they did apply this aspect, they did not document its use. Only two of the studies (Cross et al., 2012; Enyedy & Mukhopadhyay, 2007) contained enough details to be able to recognize each of the three aspects of CRP in the intervention. In both of these studies, the researchers reported community advocacy as a product of utilizing CRP. Therefore, it leads one to ponder if utilizing the third component of CRP is the causal effect of community advocacy. Prior research (Young, 2010) has addressed challenges that teachers face with helping students to recognize, analyze, and critique social inequities. Teachers possibly struggle with this component due to their lack of knowledge of the social inequities that exist in our society today. I expected for community advocacy to be a direct result of CRP. Hence, future research can probe the relationship between CRP and community advocacy.

CRP helped students to gain general knowledge of concepts beyond mathematics. Depending on the topics addressed, culturally relevant lessons can be designed in a way to integrate multiple content areas. Although Enyedy and Mukhopadhyay (2007) did not discuss the general knowledge developed from their students, I would assume that their students developed all kinds of knowledge about Brown versus the Board of Education, and other laws as well as the Supreme Court. Their study actually incorporated content from social studies courses. It is also possible that the students in Hobbs' (2010) study developed general knowledge about their neighborhoods in the GIS project, or the students in Cross et al.'s (2012) study developed knowledge about the importance of eating breakfast and how it affects you throughout the day. The generation of knowledge was not addressed in their articles, but teaching mathematics in concepts connected to cultural aspects creates a chance that students will gain relevant knowledge.

Most of the studies reported increases in mathematics achievement for students participating in culturally relevant mathematics pedagogy. Only two of the studies reported negative results of participation in their interventions. The first author (Walker, 2009) described inconsistent attendance as a possibility for the negative difference in scores on the WRAT. The second author (Hobbs, 2010) attributed many possible factors for the negative difference in mathematics scores, such as limited project length, individual instead of group focus, sample size, selection of NAEP questions, and attendance. Therefore, these are possible factors to be considered in future research agendas related to CRP. Other than those two negative results, the effect of CRP on mathematics achievement was consistent with improving mathematics performance for African-American students (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard et al., 2010; Tate, 1995).

The fact that there were only seven documents meeting the established criteria to be included in the meta-synthesis, out of 415 hits, demonstrates the lack of research on this topic of interest and thus suggests the need for more research. Of particular interest was the fact that four of the documents were published articles and three were dissertations. Because so many (almost half) of the documents were dissertations, I conclude that there is an increasing interest in new scholars on the effect of CRP in the mathematics classroom for African-American students. Therefore, research on this topic may already be in the process of growing.

Limitations of Study

When conducting a meta-analysis or meta-synthesis, there is a risk of leaving out literature. In the present study, it is possible that there were some studies that actually engaged African-American students in CRP but did not classify the instruction or activity as CRP. Also, having rigid criteria produces a risk of losing relevant data

(Jensen & Allen, 1996). As a result, there may be some literature missing in this meta-synthesis that could also be of importance and help to provide evidence of the effects of mathematics CRP on African-American students. In addition, only three of the seven studies included in this meta-synthesis were articles from peer-reviewed journals. Three of the remaining four studies were dissertations and the fourth study was a conference proceeding. Therefore, some may argue that against the credibility of the results due to the fact more than half of the studies were not peer-reviewed.

Conclusion

The results from prior culturally relevant mathematics interventions include an increase in mathematics achievement for African-American students. All of the seven documents reported favorable outcomes for an improvement in mathematics achievement. Students were able to learn mathematics content such as the statistical process, statistical measures, using data to support claims, and adding integers. Students also gained general knowledge from participating in CRP, such as knowledge of the Underground Railroad, the history of African-Americans, and famous African-American mathematicians and their contributions to the field of mathematics. Therefore, students that have participated in mathematics CRP studies in the past have witnessed an increase in mathematics achievement and gained general knowledge.

CRP was used as a source of empowerment for African-Americans through many facets. These facets include engaging in learning, developing life skills, developing habits of learning, participating in community advocacy, gaining general knowledge, and increasing mathematics achievement. Students experienced increased engagement in the learning process while partaking in mathematics CRP. They also developed life skills such as improvement in communication, collaboration, cooperation, and reasoning which will help to prepare them to be productive citizens in a democratic society. Students participating in CRP developed transferrable habits such as taking responsibility for their own learning, turning in homework assignments more frequently, reflecting on their own thinking, and increasing their inquiry. They desired to participate in community advocacy as a way to make a difference in the world. Also, students experienced an increase in mathematics achievement and general knowledge. All of these facets mentioned contribute to the ways in which CRP was used as a source of empowerment for African-American students.

The findings of this meta-synthesis lead to many suggestions for future research. The first and most important suggestion for future research is the need for understanding the effects of mathematics CRP on African-American students. The fact that there were only seven documents that made it to the final stage of the meta-synthesis contributes to this suggestion. Also, future studies should explore relationships between CRP and attitude, confidence, and behavior. Future research can also examine the relationship between the third component of CRP and community advocacy. Future research suggested by authors discussed in this study includes intervention length, the role of gender, sample size, and attendance. Hence, there is a wide range of opportunities for researchers to explore.

Research-based strategies that increase achievement and access need to be implemented by teachers that in turn help students to develop mathematical power

(Croom, 1997). Merriam Webster defined brilliant as “very bright or glittering” and “distinguished by unusual mental keenness or alertness”. Placing African-American students in supportive learning environments, such as the pedagogical environment of Ladson-Billings’ CRP, will give them the opportunity to, in the words of famous pop singer Rihanna (Fenty, 2012), “shine bright like a diamond!”

CHAPTER III

SUPPORTING HIGH SCHOOL STUDENTS' LEARNING OF MATHEMATICS: A CULTURALLY RELEVANT INTERVENTION

Mathematics has become a forerunner subject, as it is argued that knowledge of mathematical skills is necessary to living a productive life in a democratic society (Capraro, Capraro, & Jones, 2012). It is also argued that knowledge in mathematics is necessary in order to maintain a productive economy due to the vast growth in technology (Business Higher Education Forum, 2010). Currently, the United States lags behind other technological nations in mathematics and science achievement (Ladson-Billiings, 1997). The U.S. rank number 32in mathematics (Peterson, Woessmann, Hanushek & Lastra-Anadón, 2011). In order to improve the United States' standing overall in mathematics, a careful examination of the progress of U.S. students in mathematics was conducted (Flores, 2007; Lubienski, 2006). Data from the National Assessment of Educational Progress (NAEP) revealed that by the eighth grade, 91% of African-Americans and 87% of Latino students are not proficient in mathematics (Flores, 2007). Also, in the twelfth grade, African-American and Latino students perform the same as eighth grade White students on the NAEP mathematics assessment (Flores, 2007). These results are consistent on both the national and local levels. Mathematics has been taught to favor the dominant mainstream culture (Ladson-Billings, 1995b). Therefore, in order to be successful in mathematics, a minority student has to either conform or learn to adapt to the mainstream culture. The good news is that present day reform is making attempts to focus on and improve multicultural education in mathematics.

Some researchers have argued that various types of reform will improve mathematics education for minority students. Consistent across the literature was the recommendation to implement a culturally relevant pedagogy (CRP) in an effort to increase mathematical performance and understanding among African-American students (Cooks, 1998; Gay, 2002; Ladson-Billings, 1995d; Leonard et al., 2010; Tate, 1995; Ware, 2006). Therefore, educators must begin implementing a culturally relevant pedagogy to increase student enrollment and to improve student engagement and academic achievement (Cooks, 1998). Culturally relevant pedagogy also has the ability to shape students' mathematical identity which is necessary in achieving mathematical success (Leonard et al., 2010). Mathematics as it is taught today within the classroom is divorced from the everyday life experiences of African-American students (Ladson-Billings, 1997). Mathematics instruction today emphasizes repetition, drill, convergence, right answer thinking, and predictability (Ladson-Billings, 1997). Researchers agreed upon the fact, that in order to improve mathematics learning among African-American students, knowledge and skills has to be placed in the context of the everyday lives of the students (Gay, 2002; Ladson-Billings, 1997; Ware, 2006). Failure to provide African-American students with a mathematics curriculum, instruction, and assessment that focus on their experiences, culture, and traditions is an issue that prevents African-Americans from achieving mathematics equity in education (Tate, 1995). Therefore, in order to achieve success, mathematics teaching and learning have to be deeply embedded in the everyday contexts of African-American students' lives and culture (Gay, 2002; Ladson-Billings, 1997).

Culturally Relevant Pedagogy

Culturally relevant pedagogy was defined by Ladson-Billings (1995d).She studied a group of teachers who were successful with African-American students, and as a result she developed the grounded theory of CRP. She defined CRP as "a theoretical model that addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools perpetuate" (Ladson-Billings, 1995d, p. 469). CRP was originally described as a mechanism to help African-American students achieve academically, but throughout the years other researchers have also studied the success of CRP with Mexican American and Hispanic students. Therefore CRP has developed a track record of helping minority students achieve academically (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Gutstein et al., 1997; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard et al., 2010; Tate, 1995).

The first aspect of CRP is student centered. CRP produces students who can 1) achieve academically, 2) maintain cultural integrity, and 3) recognize, analyze, and critique social inequities (Ladson-Billings, 1995d). Students being able to achieve academically means that they are able to read, write, speak, compute, pose, and solve problems at sophisticated levels (Ladson-Billings, 1995d). Academic excellence is obtained through the nature and presentation of the content being taught. Maintaining cultural integrity involves the students being able to maintain who they are while negotiating the academic demands and coping with the dominant mainstream culture present in their schools. This can be done through the acceptance, appreciation, and affirmation of the culture of the students present in the classroom. Culture refers to the deep structures of knowing, understanding, acting, and being in the world and includes various aspects such as, dress, language, interaction styles, and cultural history (Ladson-Billings, 1997). Critiquing social inequities requires that students can realize that social inequities exist within our society, and students can analyze and critique these social inequities using the content being taught in the classroom. Students' ability to recognize, analyze, and critique social inequities is a way to prepare students to be productive citizens in a democratic society. The first aspect of CRP specifically deals with the student and the three expected outcomes of succeeding academically, maintaining cultural integrity, and critiquing and analyzing social inequities.

The second aspect of CRP is a focus on the teacher. Successful teachers of African-American students share common beliefs about their conceptions of self and others, conceptions of knowledge, and social relations (Ladson-Billings, 1995d). Teachers who successfully implement CRP hold conceptions of self and others that include: 1) believing that all children are capable of academic success; 2) seeing their pedagogy as art; 3) seeing themselves as members of the community; 4) seeing teaching as a way of giving back; and 5) believing in pulling knowledge out of children (Ladson-Billings, 1995d). The teachers' conceptions of knowledge include: 1) knowledge is shared, recycled, and constructed; 2) knowledge must be viewed critically; 3) they must be passionate about knowledge and learning; 4) they must scaffold to facilitate learning;

and 5) assessment must be multifaceted. Social relations held by the teacher were also important in the success of African-American students. The teacher who effectively implemented CRP maintained fluid student teacher relationships, demonstrated a connection with all students, developed a community of learners, and encouraged students to learn collaboratively (Ladson-Billings, 1995d). The teacher must respect and have knowledge about students' lives, culture, and experiences in order to use them in instruction (Malloy & Malloy, 1998). The beliefs of the teacher are key in the implementation of CRP.

Purpose of Research

The research literature contains many recommendations to use CRP (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Gutstein et al., 1997; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard et al., 2010; Tate, 1995), but very little literature was found that reported the obtained effects of CRP on African-American students' mathematics achievement. There were seven documents found that discussed African-American students in CRP and reported on mathematics outcomes. The search resulted in one qualitative (Cross et al., 2012), four quantitative (Hobbs, 2010; Langlie, 2008; McClain & Berry, 2009; Walker, 2009), and two mixed-methods (Enyedy & Mukhopadhyay, 2007; Leonard et al., 2005) studies. Six of these seven studies reported on positive mathematics achievement for African-American students. Some of the documents also reported on an increase in engagement, life skills, habits of student learning, general knowledge, and community advocacy.

As reported in a meta-synthesis future research should continue to study the effects of CRP on African-American students' mathematics achievement. Therefore, the purpose of the current study is to contribute to the existing literature on the effects of CRP on African-American students' mathematics achievement. The following research questions were addressed: 1) How is African-American students' mathematics performance effected after participating in culturally relevant mathematics instruction?; and 2) What is the extent of the effect? The questions were addressed by engaging a group of students in a culturally relevant mathematics intervention.

Methodology

The Setting and Participants

Frankfort High School (pseudonym) is a Title 1 high school located in a southern state where the research was conducted. The high school was selected due to its accessibility to the researcher. A different Title 1 high school was originally selected to conduct the research, but due to some unfortunate circumstances the research site had to be changed. The researcher had a relationship with the Frankfort principal, and therefore submitted a proposal to conduct the study at the site. Written permission was granted by the school principal and the school district. The ethnic distribution of the school was 27% African-American, 52% Hispanic, and 21% White. The student population consisted of 73% economically disadvantage students. This particular high school was an alternative campus for students placed at-risk. The ages of the students ranged from 16 to 22.

There were 42 students who were selected to participate in the study. During the time of the research, students were preparing for the state standardized mathematics assessment. Students taking the assessment preparation course were the targeted participants. The campus principal allowed the researcher to teach the assessment preparation course. The course was used to conduct the culturally relevant intervention. Students were given the opportunity to attend the researcher's class, or continue in their regular assessment preparation class. The average mathematics class size in this particular school district was 20 students; therefore, 42 students were selected at the recommendation of the principal to allow for a group of the average class size because the attendance rate at Frankfort was an issue of concern. All of the students selected to participate were on an Algebra 1 skill level. Some of the students had failed the mathematics state assessment test before, and some were taking it for the first time. Thirty seven of the students agreed to participate in the study and their ethnicities are presented in Figure 2. Nineteen of the students were females and eighteen males.

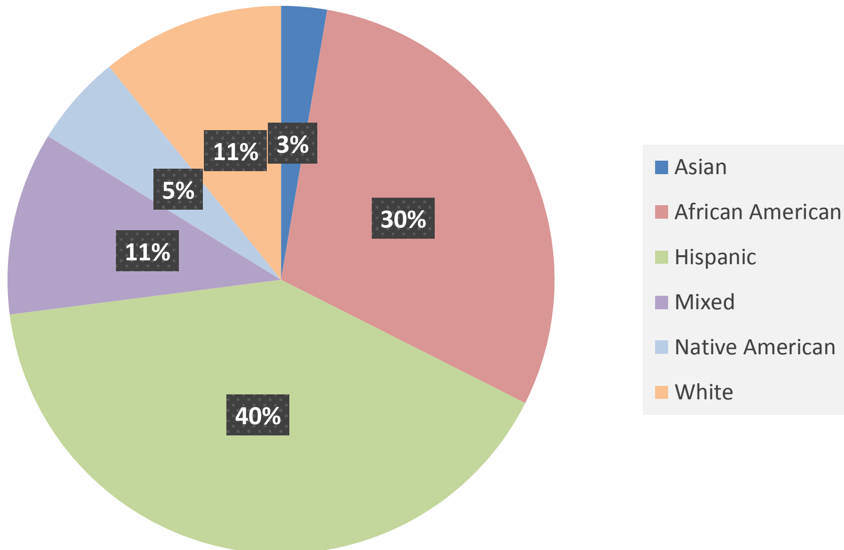

Figure 2. Ethnicities of students agreeing to participate in the study.

Research Design

A single-group pretest-intervention-posttest design was used in the study. The intervention consisted of all 37 students participating in ten class periods with the teacher-researcher in which eight of the classes consisted of culturally relevant mathematics lessons. Table 3 details each class period. The class did not meet ten consecutive days, but was scheduled on a non-routine basis according to a schedule that was already in place by the school administrators. Therefore, the intervention lasted over a one-month period. The teacher-researcher had six years of developmental mathematics teaching experience at the college level and eight years of teaching and tutoring mathematics to K-12 students through volunteering with two nonprofit organizations (Lincoln & Guba, 1990). On the first day of the intervention, students were given a questionnaire in order to obtain information about their culture. The information from the questionnaire was analyzed and used to develop the eight culturally relevant lessons implemented by the teacher-researcher.

Table 3

Schedule of Culturally Relevant Intervention

Week	**Type of Instruction**	**Activity**
Day 1		Introduction/Ice Breaker Who Am I? Activity Sheet Pretest
Day 2	Culturally Relevant	Lesson 1: Introduction to Quadratic Functions – Teen Pregnancy
Day 3	Culturally Relevant	Lesson 2: Exploring Graphs of Quadratic Functions – Teen Pregnancy
Day 4	Culturally Relevant	Lesson 3: Transformations of Graphs – Perinatal HIV Rates
Day 5	Culturally Relevant	Lesson 4: Understanding Properties of Graphs of Quadratic Functions – Teen Smoking
Day 6	Culturally Relevant	Lesson 5: Simplifying Polynomial Expressions
Day 7	Culturally Relevant	Lesson 6 – Solving Quadratic Equations by Quadratic Formula – Football and Soccer
Day 8	Culturally Relevant	Lesson 6 – Solving Quadratic Equations by Quadratic Formula
Day 9	Culturally Relevant	Lesson 8: Introduction to Exponential Functions – Savings and Travel Plans
Day 10		Posttest/Interviews

The questionnaire contained a wide range of items to capture the interests of the students, such as items about their favorite TV show, sport, radio station, and food. It also contained items that allowed the students to talk about their personal lives, such as the number of people in their family and the places they have lived. The questionnaires were read and reviewed to find commonalities among the students. The most common characteristic of the students was that their favorite sport was either football or soccer. Also, there was an item that stated “I have never . . .”, and a number of students reported that they have never traveled outside the state of Texas or outside of their city. Also, a large number of students reported they have never had a disease, smoked, or drank alcohol. There was also an item that prompted students to state the accomplishment they were most proud of, and a number of students stated they were proud that they did not have children or have ever been pregnant. Each of the above topics were common answers to the questionnaires and were chosen as topics for the mathematics lessons to embed them within the students’ culture.

The mathematics content referenced in the seven studies from a meta-synthesis were statistics (Cross et al., 2012; Enyedy & Mukhopadhyay, 2007), fourth grade mathematics (Leonard et al., 2005), adding integers (McClain & Berry, 2009), and Algebra 1 related (Hobbs, 2010). The remaining two studies did not include enough information to determine the mathematics content (Langlie, 2008;Walker, 2009). In the present study, the researcher decided to focus on one of the areas that were underrepresented but a very important high school topic. Therefore, the researcher decided to focus on algebraic topics. All of the students who agreed to participate in the study were on an Algebra 1 level. In particular the topic of functions in algebra is extremely complex (Leinhardt, Zaslavsky, & Stein, 1990). In the state curriculum for Algebra 1, two main families of functions (linear and quadratic) are covered extensively, and one function (exponential) briefly. Because quadratic functions are more complex than linear functions, the researcher decided to focus the bulk of the lessons on quadratic functions, with one lesson dedicated to a brief introduction to exponential functions.

Eight lessons were developed by the researcher relating the culturally relevant topics to quadratic and exponential functions. Only seven lessons (See Appendix A) were actually utilized. The students were having difficulty with using the quadratic formula; therefore, lesson 7 (solving quadratic equations by factoring) was done away with and lesson 6 (using the quadratic formula to solve quadratic equations) expanded to cover two course periods. The lessons were not presented in order of popularity of topics among students, but in an order that allowed for students to build on knowledge obtained from previous lessons. Each lesson is described below to demonstrate the scaffolding of the learning.

Lesson 1. This lesson began with a video (Oprah Winfrey Network, 2012) of three pregnant teenagers sharing their stories of the difficulties they have encountered since becoming pregnant. The video was followed by a conversation on teen pregnancy. The students were then given a table of the number of live births per 1,000 females in 15-19 year olds in the United States by ethnicity (National Center for Education Statistics, 2007). Students were asked a series of questions about the number of live births for different years in which they determined the values from the table. The students were eventually asked to find the number of live births for a year that they did not have information. Students inquired about how to find the values for future years, and at this moment, the students were introduced to the idea of functions and their uses. Using a TI-84 graphing calculator, each student plotted their ethnicity and observed the plots. The plots for each ethnicity followed a parabolic curve in which the graph began by increasing, reached a peak and started to decrease. Students talked about the shape and pattern of the graph, and learned how to find an equation that best fit their points using quadratic regression on the calculator. Students learned how to use their equation to find the expected number of live births in the future for their ethnicities. Students also recognized, analyzed, and critiqued the social inequities that existed within society for teen parents. The overall objective of lesson 1 was to introduce the students to quadratic functions using the topic of teen pregnancies. A copy of all lessons is in the Appendix.

Lesson 2. This lesson also covered the topic of teen pregnancy. Students observed another video (ABC News, 2009) about a family in which teen pregnancy was a continued cycle, followed by a conversation of generations of teen pregnancy. This conversation led to students talking about the social inequities that exist within society that allow this cycle to continue. Students used all of the equations that were generated in lesson 1 to talk about the graphs and the trends in the graph. Students were led to explain the behavior of the graph, compare the graphs of different ethnicities, and were prompted to read the graph to determine values (the number of live births). Students were also briefly introduced to terms such as vertex, parabola, maximum, and minimum. As students described certain aspects of the graph, the terms associated with those aspects were introduced. Students learned about the domain, range, and the parent function of quadratic functions. The overall objective of lesson 2 was for students to be able to read the graphs of quadratic functions using data from teen pregnancy rates in the U.S.

Lesson 3. This lesson began with two videos (Garcia, 2010; Healthguru, 2008) containing general information about HIV/AIDS and testimonies from teens to middle adults with HIV/AIDS, followed by a conversation on how the students view people with the disease. Students were then presented with a table of the number of HIV infected infants from the years 1985 to 1998 (Taylor et al., 2012). Students plotted the data and were able to identify the quadratic nature of the graph. Therefore, using quadratic regression the students came up with the equation to represent the data. The graph began by increasing, reached a peak and started to decrease. Students then watched another video (Desertperinatal, 2010) about perinatal HIV infection, followed by a conversation about the video. The teacher then asked the students to change the value of c in their quadratic equation multiple times, and had the students explain what happened to the graph. This was repeated multiple times. Students noticed that changing the value of c in the quadratic function only shifted the graph up or down depending on the value of c. Students were also able to make the connection that the value of c was where the graph crossed the y-axis. The teacher then asked the students to change the value of a multiple times. The teacher had them repeat this until the students noticed the effect of the value change. Students observed that changing the value of a made the graph wider or narrower depending on the value. The students also noticed the effect of changing the a to a negative number, that the graph reflected over the x-axis. Therefore, students were able to make the connection that the value of a determined which way the graph opened, and depending on which way the graph opened determined whether the graph had a maximum or minimum. The teacher also had the students explain the conceptual meaning of each change in the graph (What does this mean for the number of infants born with HIV?). This lesson ended with students recognizing the social inequities that exist within society toward people with HIV/AIDS. The overall objective of lesson 3 was for students to be able to transform the graphs of quadratic functions using the topic of perinatal HIV infections.

Lesson 4. This lesson covered the properties of the graphs of quadratic functions. The students began by taking a teen smoking quiz (Intelihealth, 2013). The quiz contained ten questions about general information relating to teenagers and smoking. The quiz was followed by a discussion of their perspectives of teenagers who smoked. A table of marijuana and cigarette use among youths aged 12 to 17 from 2002 to 2010 was presented to the students (Substance Abuse and Mental Health Services Administration, 2013). Students plotted the data and observed that the points followed a parabolic path that began by decreasing, reached a minimum and started to increase. Therefore, using quadratic regression students determined the quadratic equations that best fit the data (one for cigarettes and one for marijuana use). Students were able to talk about properties of the graphs such as whether they had a maximum or minimum. Students were also led to find the maximum or minimum using the calculator. Students were introduced to terms such as axis of symmetry and zeros. Students were able to associate the relationship of zeros with the x-intercepts. According to the graphs of cigarette and marijuana use, students were able to determine that neither of them had zeros and interpreted this as teens will always smoke. The students revisited the graphs of perinatal HIV infections and teen pregnancy to determine the maximum or minimum of those graphs, the zeros, and interpret their meaning. This lesson ended by a conversation about the effects of tobacco use and the social inequities that exist within society related to tobacco use. Lesson 4 related teen smoking to properties of the graphs of quadratic functions.

Lesson 5. This lesson involved teaching students about simplifying algebraic functions. This particular lesson was not related to any of the topics from the questionnaire because the researcher had a difficult time connecting any of the topics to the algebraic concept. Instead, the researcher used cultural aspects of African-American students such as movement and orality (Boykin, 1994), and an affinity for rhythm and pattern (Ladson-Billings, 1997). Students were engaged in a conversation about what it means to simplify. Students used individual white boards to write a chosen algebraic term from a pool of monomials presented by the teacher. Students were able to create their own leading coefficient to the terms. Students then had to walk around the room (using movement) and find other students with similar terms (looking for patterns) and simplify all of their terms to create one term. The whole class then had to take all of the terms and write the algebraic expression on the board in standard form. Students were not provided any definitions and had to use technology as a group to determine the meaning of algebraic vocabulary such as like terms, leading coefficient, standard form, degree of term, etc. The teacher served as a facilitator to the activity. This activity was repeated several times to allow students to familiarize themselves with terms and operations. The teacher played popular music while students moved around and conducted the activity. Students were then guided into multiplying monomials by binomials, and binomials by binomials. This lesson ended with students practicing multiplying and simplifying algebraic expressions using the computer (Mangahigh, 2013). Lesson 5 connected aspects of students' culture to the algebraic concept of simplifying algebraic expressions.

Lesson 6. This lesson involved solving quadratic equations using the quadratic formula. This lesson built on the students' cultural interest in football and soccer. Students were able to go outside and throw a football and kick a soccer ball. The students signed up for a task in which they could throw a football, kick a soccer ball, receive the balls, record the data, or take the time. Each student had to sign up for at least one task. Students were engaged in a conversation about projectile motion in which they had to use technology to determine the correct definition and the quadratic formula used for projectile motion. The objective of the activity was to see who could throw the football the highest and who could kick the soccer ball the highest. Students went outside and performed the task and they were able to notice that the paths of the balls followed a projectile motion. Students had to hypothesize which football and soccer ball they thought was the highest. Once students were back in the classroom, they calculated the quadratic equation of the parabolic path by using the initial height and the time it took the ball to hit the ground to calculate the initial velocity. Students calculated the maximum height of the balls and were able to determine, algebraically, which balls went the highest. Students were then engaged in a conversation about what the zeros meant for this function, and how could the zeros be calculated without looking at the graph. Students were introduced to the quadratic formula, and were taught the quadratic formula using a song to the tune of “Pop goes the weasel”. Students used the quadratic formula to determine the zeros of their graph. Students struggled with using the quadratic formula; therefore, the teacher decided to spend another day on demonstrating how to solve quadratic equations by the quadratic formula. On the second day of lesson 6, students practiced using the quadratic formula to solve quadratic equations using the computer (Cool Math, 2013). This lesson ended with students recognizing, analyzing, and critiquing social inequities that exist within society related to football and soccer. The overall purpose of lesson 6 was for students to learn to solve quadratic equations by the quadratic formula using the topic of football and soccer.

Lesson 8. This lesson was an introduction to exponential functions. The teacher began this lesson with presenting a problem to the students to decide whether they would choose one million dollars or a penny doubled every day for 30 days. Students then calculated the amount of a penny doubled every day for 30 days to determine which amount was actually the most. Students were encouraged to look for a pattern and develop an equation that represents the data. Students were introduced to exponential functions, and the standard equation for exponential functions. Students planned their dream vacation to anywhere in the world. Students used travel websites such as travelocity.com and orbitz.com to find the cheapest trip to their dream destination. Students were also introduced to the term certificate of deposit (CD), and alternative methods of saving at their local banks. Students were then prompted to write an exponential equation for a 12 month CD for a feasible amount that they could deposit at their local bank. Students then had to calculate how long it would take them to save enough money to afford their trip. Students were allowed to play with the deposit amount and the length of time in order to find an amount and a number of years suitable for their life situation. Students were shown a video about the importance of saving. This lesson ended with a conversation about whether students saved, and whether they though minorities saved money, and why or why not. Students eventually ended up talking about social inequities that exist around the topic of savings. The objective of lesson 8 was to introduce students to exponential functions by saving for the dream trip.

Instruments

Pre- and post-assessments were developed by the researcher that consisted of the same questions (See Appendix A). Each lesson was assessed using four multiple choice questions with four options. Therefore the assessment used for pre- and post-test contained 32 questions. The questions were chosen from prior mathematics ninth-grade, tenth-grade, and exit-level state assessments. The assessments were given on the first and last days of the intervention, respectively. Although lesson 7 was not covered in the intervention, students still obtained enough knowledge to be able to answer the questions on the assessment that were selected to cover the lesson 7 topics. Lesson 6 covered using the quadratic formula to solve quadratic equations, the most general solution strategy, and lesson 7 would have focused on solving quadratic equations by factoring. Because students can solve all quadratic equations using the quadratic formula, they were still able to answer the questions that were easily factorable that were intended to measure lesson 7. Therefore, information pertaining to all 32 questions was covered during the intervention. The assessments were graded on a 100-point scale; the number correct divided by 32 and then multiplied by 100.

The teacher-researcher kept a journal in which she documented field notes each day classes were taught. Student work was also collected and used for data collection purposes. The teacher took attendance each day to track the participation of students in the culturally relevant lessons.

Classroom Description

A Frankfort teacher who had a conference period during the time the researcher was scheduled to teach, allowed the researcher to use her classroom. Her room was a computer lab that contained desks and a computer for each student. Her room was also equipped with a projector and screen that connected to the teacher's computer. The teacher's computer controlled the computers of each student, with the ability to lock their screens and block internet access. The classroom did not have a white or blackboard, but contained a document camera that was also connected to the projector and screen. Therefore, the researcher was able to transfer back and forth between the document camera and the computer screen. The computer was used mostly to show videos and display articles and other pertinent information found online. The document camera was used mostly while answering student questions and for keeping track of student discussions. The administrators also provided the teacher-researcher with a classroom set of TI-84 graphing calculators, but there was not a navigation system set-up in the classroom to control or demonstrate step by step processes. The classroom setting is described because it is important to note that this study was not conducted in a typical mathematics classroom setting.

Results

Paired samples *t*-Tests were conducted to determine differences between means of pre- and post-assessments within groups. The students were divided into groups based on their ethnicity, and the means were compared for the whole group. The presentation of the assessment scores by ethnicity is not used to compare results by ethnicities for a comparison group is not necessary (Gutiérrez, 2008). It is solely presented in an effort to determine the effects of the intervention for each ethnicity. Also, conducting multiple *t*-tests increases the probability of Type I errors in the study (Thompson, 2006). Therefore, the Bonferroni correction was used to control the probability of making a Type I error anywhere within the study (See Table 4). Data was presented for only 23 students because these were the only students that attended at least one lesson of the intervention and took both the pre- and the post-assessment. Thirteen students missed the post-assessment due to attendance, and one student took both the pre- and post-assessment but never attended any of the lessons.

Table 4

Paired Sample t-Test for Pre- and Post-Assessments by Ethnicity

Ethnicity	**Number in Group**	**Pre Assessment Mean (SD)**	**Post Assessment Mean (SD)**	**Mean Difference**	***t***	***p-value***	***d***
African American	5	37.40 (24.058)	41.40 (16.562)	+4.00	-.460	.670	.197
Bi-Racial	4	43.00 (38.061)	50.00 (24.386)	+7.00	-.718	.525	.224
Hispanic	8	25.00 (7.521)	43.00 (14.010)	+18.00	-4.567	.003*	1.672
Native American	2	48.50 (10.607)	57.50 (2.121)	+9.00	-1.000	.500	1.414
White	3	27.00 (23.065)	44.67 (14.012)	+17.67	-1.999	.184	.953
All Students	23	32.61 (21.561)	44.70 (15.738)	+12.09	-3.850	.001*	.648

Note: The sum of the number in group for all ethnicities does not equal total students because there is an Asian student who is included in the all students group but does not have his own ethnicity category because there needs to be at least two in order to perform the *t*-test. Bonferroni correction: $* p < \frac{0.05}{6} = .008$.

It was hypothesized that CRP in a mathematics classroom will enhance mathematical learning for African-American students, as well as for other ethnicities. Therefore, the results in Table 4 were used to accept or reject the hypothesis that there was no difference between pre- and post-assessment scores. The differences in means were statistically significant for the whole group ($\bar{X}_{Pre} = 32.61,\ SD_{Pre} = 21.561;\ \bar{X}_{Post} = 44.70, SD_{Post} = 15.738$) and for Hispanics ($\bar{X}_{Pre} = 25.00,\ SD_{Pre} = 7.521;\ \bar{X}_{Post} = 43.00, SD_{Post} = 14.010$). Cohen's *d* effect size shows the extent to which the sample diverges from the null hypothesis (Thompson, 2006). The effects (*d* = .648) for all students resulted in a letter grade increase. The effects (d = 1.672) for Hispanic students alone resulted in an increase of nearly two letter grades. Based on the results from the t-test, overall all students benefitted from the intervention.

Although only the results for the group of all students and Hispanic students were statistically significant, there were also notable results for the other groups. African-American students' scores on average, increased by almost a half a letter grade (Mean Difference = +4.00). The fact that the Cohen's d effect size was low (d=.197) reveals that this group of students was capable of a much bigger change. Therefore, more work could have been done through these students. White students had an effect (d = .953) that resulted in almost a two letter grade increase as well. Native American students had an effect (d = 1.414) of an increase of almost one letter grade. The results for White and Native American students may not have been statistically significant due to sample size because there were only three and two students, respectively. Also, for all of the groups tested, with the exception of Hispanic students, the standard deviation decreased from pre- to post-assessment implying that the students' scores were less spread out and more similar to each other. Therefore, students became more similar to each other in their mathematical performance after participating in culturally relevant instruction.

In order to determine if the length of time the students' participated in the intervention was correlated to the mathematics performance of the students, Pearson r correlations were calculated between the number of hours participating in instruction and the difference in pre- and post-assessments. Table 5 presents the correlations and Figure 3 represents a scatterplot of the relationship. The correlation for Native American and

White students were omitted due to the size of the groups. There were only two Native Americans and three White students, and a Pearson r correlation between a sample of size two will always result in $r = \pm 1$, and a size of sample three will always be really close to a perfect correlation. All four of the remaining correlations presented are small and close to zero.

Table 5

Relationship between Hours of Instruction and Mathematics Performance

Ethnicity	Correlation with Hours of Instruction
African American	-.241
Bi-Racial (Two or More Races)	.285
Hispanic	.034
All Students	-.117

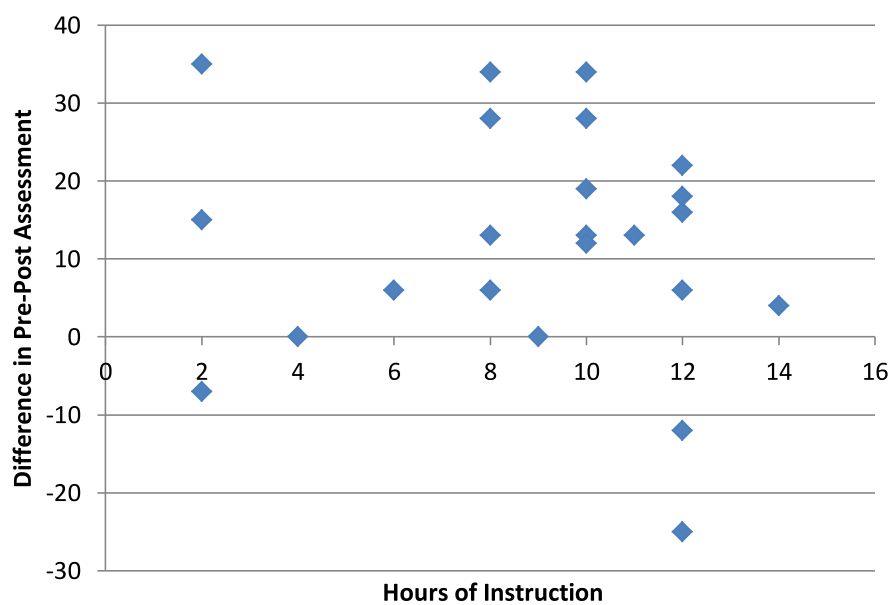

Figure 3. Relationship between hours of instruction and difference in test scores.

The researcher had a serious concern about two of the students that had been participating frequently and seemed to be benefiting from the intervention. One student was an African-American female that had participated in 12 hours of instruction. On the day of the post-assessment, this particular student came to class furious and in tears. The teacher pulled her aside to talk with her, and she was very angry about her boyfriend calling her a bad name. After trying to calm the student down, the student was still asked to take the test and to do her best. The teacher was concerned because she knew that the student was not in the right mind frame to be taking a test. The second student was a Bi-Racial female that had participated in 12 hours of instruction. This particular student came to class on the day of the post-assessment in a very different mood than normal, but the teacher did not think much of it. While taking the test, the teacher found this student with her head lying on the desk. The teacher went to talk with her, and the student expressed that she was experiencing a really bad migraine headache. The teacher could not administer medicine to the student, and asked the student to just finish the test as best as she could. This particular incident was of concern to the teacher because the teacher knew that the student was not in the right mind frame to be taking a test. The researcher wanted to use personal judgment and remove both students from the data, but there could be many biases associated with the personal judgment of the researcher, especially in the first case. Therefore, the researcher removed only the second student (Bi-racial female) from the data because there was no doubt that a person experiencing medical issues during the moment of testing was not in the correct mind frame to take an exam. Hence, the *t*-tests were repeated with the removal of the one student.

The new data analyses resulted in changes for Bi-Racial and all students (See Table 6). The mean difference in pre- and post-assessment increased from 7.00 to 13.33 for Bi-Racial students. Their effect size also increased from .224 to .358. The effect for Bi-Racial students resulted in almost a letter and a half grade increase. Before the student was removed from the analysis, the effect was less than a letter grade increase. A low effect size (*d*=.358) for Bi-Racial students, reveals that this group of students is also capable of a greater impact. Dropping the one student also resulted in an increase in the difference between pre- and post-assessment for all students. It changed from a positive 12.09 to positive 13.18. The effect (*d* = .698) for all students was roughly unchanged. Therefore, dropping the one student had little effect on the results for the groups of all students and Bi-Racial students.

Table 6

Paired Sample t-Test for Pre- and Post-Assessments by Ethnicity without One Student

Ethnicity	**Number in Group**	**Pre Assessment Mean (SD)**	**Post Assessment Mean (SD)**	**Mean Difference**	***t***	***p-value***	***d***
African American	5	37.40 (24.058)	41.40 (16.562)	+4.00	-.460	.670	.197
Bi-Racial	3	40.67 (46.264)	54.00 (28.213)	+13.33	-1.271	.332	.358
Hispanic	8	25.00 (7.521)	43.00 (14.010)	+18.00	-4.567	.003*	1.672
Native American	2	48.50 (10.607)	57.50 (2.121)	+9.00	-1.000	.500	1.414
White	3	27.00 (23.065)	44.67 (14.012)	+17.67	-1.999	.184	.953

Table 6 Continued

Ethnicity	Number in Group	Pre Assessment Mean (SD)	Post Assessment Mean (SD)	Mean Difference	*t*	*p-value*	*d*
All Students	22	31.82 (21.725)	45.00 (16.039)	+13.18	-4.281	.000*	.698

Note: The sum of the number in group for all ethnicities does not equal total students because there is an Asian student who is included in the all students group but does not have his own ethnicity category because there needs to be at least two in order to perform the *t*-test. Bonferroni correction: $* p < \frac{0.05}{6} = .008$.

Removing the Bi-Racial student from the data resulted in not reporting the correlation between difference in pre- and post-assessment and number of hours of instruction for Bi-Racial students because the sample size was decreased from four to three which would cause the correlation to be closer to a perfect correlation due to sample size. Removing the student from the data resulted in changes in the correlation between the number of hours of instruction and the difference in pre- to post-assessment for all students. The correlation remained negative but got closer to zero, which was consistent with the remaining correlations that were presented in Table 7. Figure 4 represents the new scatterplot of the relationship with the one student removed. These correlations exemplify that there was no relationship between the number of hours of instruction and the difference in pre- to post-assessment.

Table 7

Relationship between Hours of Instruction and Mathematics Performance without One Student

Ethnicity	Correlation with Hours of Instruction
African American	.042
Hispanic	.034
All Students	-.016

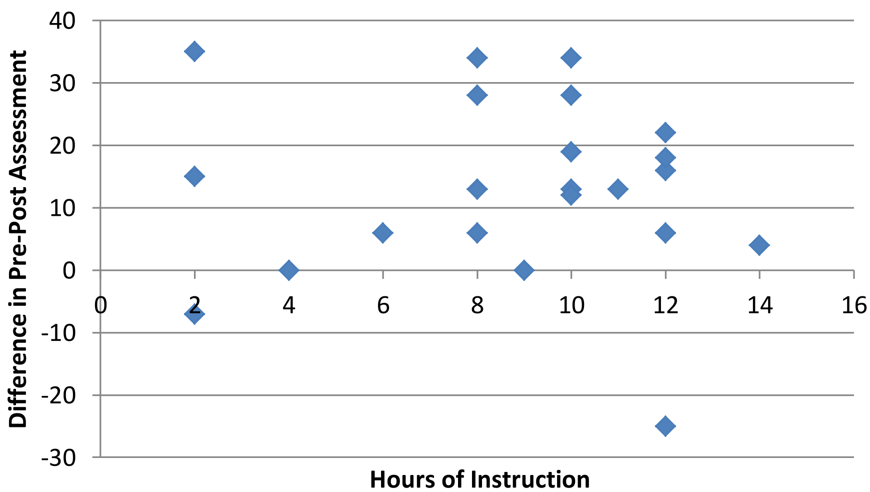

Figure 4. Relationship between hours of instruction and difference in test scores without one student.

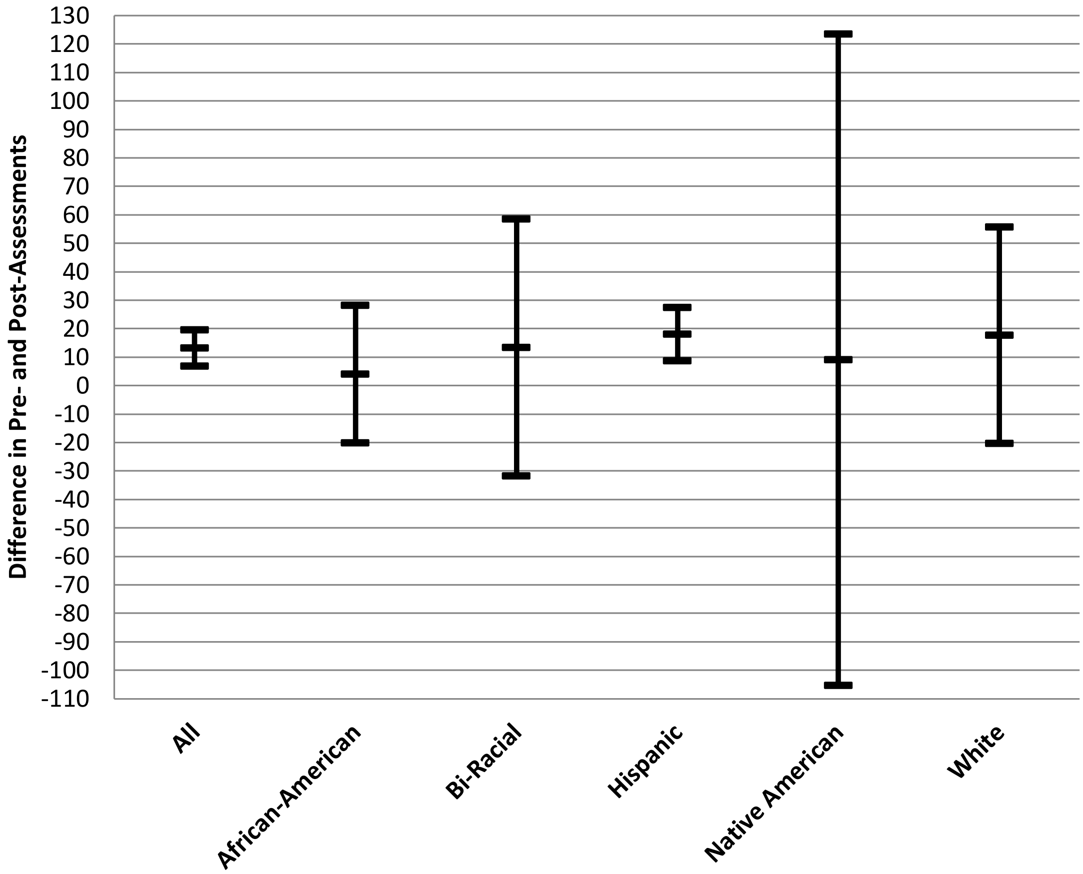

Figure 5. 95% confidence intervals of the difference in pre- and post-assessments.

Ninety-five percent confidence intervals for the difference in pre- and post-assessments were computed (See Figure 5). Confidence intervals communicate information about the point estimate and the precision of the point estimate (Thompson, 2006). Wider confidence intervals imply less precise estimates (Thompson, 2006). Therefore, the estimates of difference in test scores for the group of all students and Hispanic students were more precise, whereas the estimate for Native American students was less precise. Also, the lower limit of the confidence intervals for the group of all students and Hispanic students was a positive number whereas the lower limit for all other groups was a negative number. These lower limits were likely lower bound estimates of the parameter; therefore it was plausible that the groups of all students and Hispanic students had positive differences in pre- and post-assessments (Cumming & Finch, 2005).

Discussion

All but three students' demonstrated gains from pre- to post-assessment, and two of the three students were the students that the researcher had serious concerns about their mental state to take the post-assessment. One of those students was removed from the second data analysis. Based on the results from the pre- and post-assessments, all groups of students made positive mathematical gains. Those gains were statistically significant for all students as a whole and Hispanic students. Hispanic students seemed to have benefited the most from the culturally relevant intervention based on improvement in scores, followed by White students. African-American students made gains from pre- to post-assessment, but according to the low Cohen's *d* effect size, they could have achieved more. It is possible that African-American students did not reach their full potential because of their attendance. There were 11 African-American students that participated in the study, but only 5 of the students were included in the analysis due to attendance. Also, the students that were included in the analysis attended 9.25 hours on average of the available 16 hours of instruction. After the one student was removed, the average difference between pre- and post-assessments increased for Bi-Racial students by approximately six points. The effect size for Bi-Racial students also increased, adding more strength to the results of the assessments. Therefore, on average, all students benefited mathematically from the intervention.

The researcher hypothesized that there would be a strong positive correlation between the number of hours each student participated in instruction and the difference in pre- and post-assessment. Unfortunately, the correlation between the two resulted in a weak, negative correlation for all students ($r = -.117$). After removing the one student, the correlation for all students got weaker, but was still negative ($r = -.016$). Each correlation presented was close to zero; therefore, implying that there was no relationship between the amount of time students participated in culturally relevant instruction and their mathematics achievement. It is possible that there is really no relationship between mathematics achievement and length of time in culturally relevant instruction or that the length of time the students participated in the intervention was not substantially long enough to accurately determine a relationship. It is also possible that the students did not need to attend all of the lessons in order to get a better performance. Therefore, future research should continue to explore the relationship between mathematics performance and length of time in culturally relevant instruction. In addition to improving mathematics achievement, CRP has the ability to increase student engagement, life skills, habits of student learning, general knowledge, and community advocacy. There was not an instrument employed in this study to measure the impact of CRP on any of these topics, but teacher observations and field notes were used to make claims about the effect of CRP on these topics with this group of students.

Student Engagement

The videos presented to students always deeply engaged the students in conversations about the topics at hand. This engagement was demonstrated in their openness to share their thoughts, feelings, and opinions. Students shared their feelings on teen pregnancy stating that they felt it was an accomplishment to be in high school and not have any children or never had an abortion. The students shared that is was so common in this day and time to see teens pregnant, stating "They [teenagers] think it's cute or something." Students also shared their feelings after watching the first informative video about HIV/AIDS they said that they perceived people with the disease as, "nasty people who had sex with a lot of people or used drugs and shared needles with others." After students were introduced to perinatal HIV, the case of contracting HIV at birth, their conceptions of the people with the disease changed. They shared, "I never thought about people that didn't do anything to get HIV or AIDS." Students also shared their feelings toward teen smokers. Some students even admitted to being smokers themselves. Approximately 80% of the class agreed to either smoking on a regular basis or having smoked before. Students were very open to discussion about the topics they viewed on the videos presented in the lessons, and the more they got to know the teacher, the more real the students were with the teacher.

Students were also passionately engaged in recognizing, analyzing, and critiquing social inequities. In the first lesson on teen pregnancies, the teacher had to give students examples of social inequities that existed with teen pregnancies, and guide them into critiquing and analyzing the social inequities. After the example was provided to the students, they were able to do all three steps on their own in the following lessons. The students also looked forward to discussing social inequities. This was shown in lesson 5 because it did not entail recognizing, critiquing, and analyzing social inequities, and students asked questions that day about doing so. Therefore, the students either got accustomed to discussing social inequities or they enjoyed discussing social inequities. Students discussed issues such as the relationship between teen pregnancy and poverty. Students also passionately addressed the fact that it was very unfair that boys can just walk away when they get a girl pregnant. Students suggested that fathers not being in the home and single parents having to work multiple jobs to provide were social issues that allowed for teen pregnancies to continue. Students also talked about how "smart" or "good" students experience inequities when they get pregnant because they are no longer viewed in a positive light. Students also discussed the fact that teen parents do not get to have the full teen experience because once they have a baby they can no longer do anything such as go to football games or social activities. Students also discussed how they felt there were social inequities in cigarettes being legal and marijuana being illegal. After taking the teen smoking quiz, students learned a lot about all of the poisons found in cigarettes and the different cancers that tobacco can cause. Students felt that cigarettes should be illegal if they contain poison and it is a known fact that they cause cancer. Students also felt that marijuana was from the earth and was a natural plant that did not cause any harm, and therefore should be legal to smoke. One student even went as far as to say that "Cigarettes are used by the CIA to kill off minorities." These are just a few examples of the social inequities that students were actively engaged in discussing.

Students were engaged in learning mathematics in this intervention because they were engaged in the topics that the mathematics was geared around. The topics were chosen based on answers from the questionnaires which came from all students and not one particular race. Therefore, the topics that the students were engaged in were related to all of their culture. One student stated, “I thought you were teaching us math”, and made this comment on multiple days. This particular student felt like she was not learning mathematics because the class was so actively engaged in the topics while all along they were learning mathematics at the same time they were talking about topics in which they were interested. Therefore, embedding mathematics lessons in the students’ culture increases student engagement in learning mathematics in this study.

Life Skills

Throughout the lessons, students were able to develop some life skills. Life skills are those characteristics developed that students use in their daily lives and are necessary for being productive citizens. Students were able to work on their communication skills by learning to communicate their ideas effectively to the class through sharing and justifying their thinking. Students also had to practice being respectful of opinions of their classmates and developing effective listening skills. In some of the lessons, students also had to work as a team which helped them in working together collaboratively instead of individually. Also, all of the lessons required some form of technology which allowed the students the opportunity to build their technological skills. Through participating in the culturally relevant intervention, students were afforded the opportunity to develop some life skills.

Habits of Student Learning

Habits of student learning are transferrable skills used to improve learning in any type of learning environment regardless of content. Students were guided into constructing their own learning. The teacher did not just give the students information but encouraged the students to seek for answers and develop their own knowledge. Students were able to find and share definitions of terms and algebraic concepts. Students also demonstrated student inquiry. After students were able to read the graphs and develop conceptual understandings of the data and graphs, they began to inquire of many things. After seeing the shape of the teen pregnancy graph, how it started increasing, reached a peak and then started decreasing, the students inquired what made teen pregnancies start to decrease. The graph reached its peak in 1991 for all ethnicities, and students hypothesized that around this time condoms or birth control were invented. Other students hypothesized that sex education was the reason teen pregnancies began to decrease. In their own personal time, students researched the dates that condoms and birth control were invented, and the dates when sex education began being taught in schools in the United States. The students came back to class the next class day and explained to the teacher that teen pregnancies began to decrease in 1991 because sex education was introduced into US schools in the early 1990's. Due to the inquiry of the students, they were able to research information and draw conclusions about information given from graphs.

Students also inquired about certain information during the lesson involving perinatal HIV infection (Lesson 3). The parabolic graph of perinatal HIV infections began increasing, reached a peak, and started to decrease. When students began to question the reason for the decrease, the teacher showed the students the last two videos of the lesson (See Lesson 3) in which HIV positive parents were able to successfully have children without passing HIV on to them because there were anti-HIV medications available to lower the risk. The students discovered that while HIV transmission decreased in general, it was relatively unchanged for African-American and Hispanic mothers due to the lack of early medical care. The teacher also had students read an article which talked about these racial disparities among perinatal HIV infection rates and reasons for the decrease and non-decrease in perinatal infections. The students were able to obtain solutions to their inquiries by viewing the videos and reading the article.

Students also inquired about information during the teen smoking lesson (Lesson 4). The parabolic curve for teen smoking rates for both marijuana and tobacco began by decreasing, reached a minimum, and started increasing again. The students inquired about what caused the graph to reach a minimum. The students recognized that the minimum occurred in the year 2008. Therefore, students concluded that teen smoking rates reached a minimum in 2008 because that is the year the country experienced an economic recession. Students concluded that parents were broke and therefore teens did not have money to buy as much cigarettes and marijuana as they had before the recession. The students stated that after 2008, the economy started doing better and the teen smoking rates started back increasing. Students were able to use reasoning and draw conclusions from information given in a graph.

The habit of student learning most utilized was student inquiry. Because the students were interested in the topics covered in the lessons, they inquired of many things. Due to their inquiry, they were able to learn how to take responsibility of their own learning. In the process of taking responsibility for their own learning, they picked up traits such as how to research and search for answers, how to use reasoning skills, and how to draw conclusions from information given. These are all skills that students can use in the learning process regardless of what content material they are learning.

General Knowledge

By participating in the culturally relevant lessons, students were able to gain general knowledge in addition to the mathematics knowledge. None of the students were able to answer the question, what is perinatal HIV infection at the beginning of the lesson. Therefore, students gained general knowledge of perinatal HIV infections, and information about medications that are available to HIV positive parents to prevent HIV from being transmitted to their babies. Students also gained general knowledge from the teen smoking quiz. Students learned about the different poisons found in tobacco and the different cancers that tobacco is known to cause. Students gained general information about planning a trip and the different options available to them in making travel arrangements. Students gained knowledge about various opportunities for investing and saving money. Students also learned general information about teen pregnancies. There are also probably a lot more general information that students gained from these lessons that are not described here, but in conclusion students gained general knowledge by participating in the culturally relevant lessons.

The teacher that allowed the researcher use of her classroom would occasionally pop in the class to get items from her desk. At times she would sit and listen to the discussion taking place among the students. One day as the researcher was preparing to go home; the teacher pulled the researcher to the side and stated that she really wanted to learn how to develop lessons similar to the ones being implemented by the researcher. The teacher also stated that she was really impressed how the lessons allowed the students to learn two things at the same time. She stated. "It's like two classes in one. The students are learning mathematics and issues related to life." In the short amount of time that the teacher witnessed the lessons, she was able to realize that culturally relevant mathematics instruction contributed to the learning of mathematics and general knowledge.

Community Advocacy

The eight culturally relevant lessons in this study did not result in community advocacy but had the potential to do so. Lessons 2, 3, and 4 contained extensions that time did not permit to be conducted. These extensions would have resulted in community advocacy performed through the students. In the lesson 2 extension students would have created a campaign to promote teen pregnancy awareness and safe sex. This campaign would have been conducted at their high school. In the lesson 3 extension students would have created an awareness campaign of anti-HIV medications to prevent perinatal HIV infections. This campaign also would have contained students promoting

HIV testing and informing other students of sites where they could get tested for free. In the lesson 4 extension, students would have created commercial advertisements to be uploaded to Youtube to prevent tobacco use among youth. All three of these extension assignments would have been promoted through the students' high school and within their communities; therefore, offering them the opportunity to participate in community advocacy. These extensions would have given the students a chance to make a positive difference in their school and community. Although these extensions were not conducted, it is not completely known whether these students have influenced the lives of others since participating in these lessons. Therefore, although the researcher did not see the community advocacy, it is still possible that some advocacy did take place through the students.

Limitations of Study

There was one particular piece of information that was important, but was not considered in the planning and conducting of this research. That is the fact that 100% of the students who participated in the study were students placed at-risk. It was not anticipated that the population would be 100% of students placed at-risk; the planning was for a more diverse group. Because of this fact, a post evaluation of the research was conducted to compare how well the research design met the principles established in the literature for students placed at-risk (See Table 8).

Hughes (2010) established ten principles of formative assessment used to maximize student learning and reduce the likelihood that students would remain at-risk. The ten principles were directed at teachers to use formatively to make adjustments in the classroom and for professional practice. Six of the ten principles were used as a form of assessment in working with the students placed at-risk in the present study.

Table 8

Ten Principles of Formative Assessment That Maximizes Students Learning and Reduce the Likelihood Students Will Remain At Risk Researcher Check List

Principle	Yes	No
1. Believe that all students can learn	X	
2. Get to know students and their community	X	
3. Learn about assessment best practices and use them with at-risk students		X
4. Be sure students understand what the goal is and what desired performance looks like		X
5. Give high quality feedback to students about their learning	X	
6. Use results from formative assessment practices to differentiate teaching	X	
7. Engage students in the assessment process		X
8. Provide students with multiple opportunities to demonstrate the desired performance	X	
9. Help students build academic self-efficacy	X	
10. Help students become self-regulated learners		X

Principles one, two, five, six, eight, and nine, of the ten formative assessment principles were satisfied by the researcher while working with the students placed at-risk in the present study. First and foremost, the researcher believed that all students could learn regardless of their culture, socioeconomic status, gender, or, race; therefore, held all students to a high standard and satisfying the first principle of formative assessment. All of the lessons were developed by the researcher getting to know the students through a student questionnaire, which satisfied the second and sixth principle. The researcher developed lessons in such a way that the tasks were broken into mini task in order to prevent the students from feeling overwhelmed, satisfied principle number eight. The researcher provided various forms of feedback to each student throughout each lesson. The feedback informed students of their current progress and provided suggestions for improvement. Feedback was often times given in the form of praise and was given individually most of the time. There were a few moments in which the researcher provided praise to students publicly, but never provided critique publicly. The timeliness and tone were always considered when providing feedback to students. Providing high quality feedback was principle five. The use of culturally relevant teaching also helped to satisfy principle six. The researcher also provided the students with multiple chances to demonstrate the desired performance which was necessary for principle nine. Expressions such as “you can do it!”, “I believe in you”, “you are very intelligent”, “that was a well thought out response”, or “that’s good” were used to praise students when necessary and helped to satisfy the ninth principle.

Principles three, four, seven, and ten of the ten principles of formative assessment were not adequately used with the students placed at-risk in the current study. Some alternative assessment methods include growth portfolio assessments and performance assessments, but the researcher failed to use either of the two alternative forms of assessment. The researcher did not provide the students with rubrics or written statements of intended outcomes. The researcher also did not allow the students to practice the task using the assessment criteria nor helped students to devise their own assessment criteria for a particular task. Therefore the researcher did not provide the opportunities described by the fourth and seventh principles. Although the researcher designed lessons which required students to develop tasks that help them take responsibility for their own learning, the researcher did not do enough to satisfy the tenth principle. The students were not given the opportunity to develop their own assessment, nor identify strength and weaknesses of neither their peers nor their own work. Students were also not given rubrics, which would have helped to make the goals of the tasks clear. Four of the ten principles of formative assessment were not sufficiently satisfied in the present study.

The lessons included extensions that would have resulted in performance based assessment which would have satisfied principle three if they had been conducted. Also, the students would have been presented with a rubric if the extension of each lesson would have been conducted. This rubric could have been designed with input from the students. Hence, if the extension lessons would have been conducted with the students, then all ten principles of formative assessment would have been satisfied. This could have possibly resulted in greater impacts on the students involved in the study.

Conclusion

Culturally relevant pedagogy is a theory of instruction recommended for increasing mathematics education among African-American students (Brenner, 1998; Cooks, 1998; Ensign, 2003; Enyedy & Mukhopadhyay, 2007; Gutstein et al., 1997; Ladson-Billings, 1995b, 1997; Langlie, 2008; Leonard, 2008; Leonard et al., 2005; Leonard & Guha, 2002; Leonard, Napp, & Adeleke, (2009); Matthews, 2003, 2008; Walker, 2009). The current study involved placing 37 students of various races in an intervention to determine the effects of culturally relevant mathematics instruction on mathematics achievement. This study showed that culturally relevant mathematics instruction not only improves mathematics education for African-American students, but for all of the students who participated. African-American students' mathematics achievement increased by a half a letter grade, whereas overall all students mathematics achievement increased by approximately one letter grade. Students not only benefited by learning mathematics from culturally relevant instruction, but also their engagement in the learning process was increased, they gained life skills, habits of student learning, and general knowledge. Students learned to take responsibility of their own learning and developed metacognitive skills which are necessary to be successful in education and in society.

Although students participated in eight culturally relevant lessons in a four-week period, there were positive impacts for these students. Imagine the impacts that would occur if students experienced more than eight culturally relevant lessons. Imagine the impacts that would occur if students learned mathematics using topics that they experience on a daily basis. According to the results from this study, more students, especially minority, need to be exposed to culturally relevant instruction which in turn means that more teachers need to learn about culturally relevant instruction and how to implement it. Mathematics is not as hard as some students think; it is just all in the way the mathematics is presented to the students.

CHAPTER IV

LEARNERS OF MATHEMATICS: HIGH SCHOOL STUDENTS' PERSPECTIVES OF CULTURALLY RELEVANT MATHEMATICS PEDAGOGY

In addition to the complexities associated with learning mathematics, African-American students also face certain challenges that have an impact on their learning. Some of the main challenges cited by African-American students themselves deal with stereotypes. Stereotypes that students talked about include: 1) Black males are more likely to dropout; 2) Students with dreads are trouble makers; 3) Blacks are intellectually inferior; 4) Only smart people take honors courses; and, 5) Only smart people can be successful in mathematics (Brand, Glasson, & Green, 2006). One particular stereotype that often times clouds the mathematics classroom is the "white male myth" which states that white boys are naturally skilled at mathematics (Stinson, 2013).Failing to confront these stereotypes have a negative impact on students' learning and participation in mathematics classes (Brand et al., 2006).

Students also cited challenges of individual institutional racism that exists. This is when "individuals intentionally or unintentionally discriminate against students of color in favor of the incorporation of policies and practices that work to the disadvantage of students of color" (Berry, 2005, p. 55). Behavior can also sometimes be an issue when it comes to African-American males. It is sometimes used to evaluate the intellectual ability of African-American students when often times there are just cultural differences in what is deemed appropriate behavior (Berry, 2005). The African-American students in Brand et al. (2006) stated that they typically had to deal with struggles of negative stereotypical images and negative perceptions which guided their teachers' thoughts and had an effect on them in the classroom. These negative stereotypical images effect students' self-esteem and discourage students from choosing science and mathematics careers (Brand et al., 2006).

As mentioned previously, African-American students face many challenges in education, but specifically in the mathematics classroom. It would be impossible to know any of these challenges without hearing the students' perspectives, and there is a lack in literature that voices the perspectives of students. The viewpoint from the students themselves is rarely heard in discussion about school reform. Howard (2002) described the absence of the voices of African American students as footsteps in the dark, because the footsteps are trying to tell us something that we need to hear but don't want to hear. There exists a need for descriptions of African American students' perceptions of their learning environments, and it is important that researchers include these individuals in their studies and include their voices in the development of solutions to the problems (Freeman, 1997; Howard, 2002). There needs to be a space where students can voice potential solutions for what they believe works best for them (Howard, 2002).

In the small amount of literature that presents the voices of African-American students on effective classrooms, these students have voiced what they believe to be effective teaching strategies in helping them be successful in learning. African American students in Howard's study (2002) believed that effective teaching practices included: 1) teachers who made their classrooms resemble home through family and community practices, beliefs, and values; 2) teachers that demonstrated culturally connected caring; and 3) teachers that used communication that contributes to an increased level of engagement and achievement in school. In addition, African-American male high school students in Moore's (2002) study stated that effective classrooms allowed them to actively participate in the learning process, work collaboratively in groups, and allowed opportunities for student discourse. Also, students in Liang and Zhou (2009) felt that using integrated technology in mathematics instruction helped them to learn mathematics better because they were more engaged in the lessons through the technology. All of these strategies were cited by the African-American students themselves as effective teaching practices.

Culturally Relevant Pedagogy

Culturally relevant pedagogy (CRP) is a theory that was developed by Ladson-Billings (1995d) after studying successful teachers of African-American students. The theory was designed from observing the common traits among the successful teachers and the characteristics of the students participating in the teachers' classes. Therefore, CRP entails two facets in which one deals with the students participating in CRP and the other the teacher implementing CRP. CRP produces students that can 1) achieve academically; 2) maintain their cultural integrity; and 3) recognize, analyze, and critique social inequities. CRP helps students to achieve academically by ensuring that a rigorous curriculum is implemented along with the culturally relevant instruction. CRP also helps students to maintain their cultural integrity by helping them realize that they can be themselves and still be successful academically. This is typically done by using aspects of students' culture in the learning process. Recognizing, analyzing, and critiquing social inequities involve including students in discussions and lessons related to social inequalities that exist within society. The three propositions related to the teacher include: 1) the CRP teacher holds positive conceptions of self, their occupation, and others; 2) the CRP teacher maintains positive social relations with all students, parents, and the community; 3) CRP teachers are passionate about knowledge and teaching and believe that knowledge is shared, recycled, and constructed (Ladson-Billings, 1995d). CRP was developed to aid in creating successful learning environments for African-American students.

Purpose of Research

Although culturally relevant pedagogy was developed for educational purposes in general, many scholars have recommended implementing CRP specifically for enhancing mathematics education for African-American students (Allexsaht-Snider & Hart, 2001; Cooks, 1998; Gay, 2002; Ladson-Billings, 1995a, 1995b, 1995c, 1995d, 1997, 2009; Leonard et al., 2010; Tate, 1995). Most research on CRP deals with aspects related to teacher implementation or student outcomes (Averill et al., 2009; Cross et al., 2012; Enyedy & Mukhopadhyay, 2007; Garcia et al., 2010, Hobbs, 2010; Langlie, 2008; Leonard et al., 2005; Lipman, 1996; Matthews, 2008; McClain & Berry, 2009; Moore, 2012; Walker, 2009) and has shown positive impacts for all students participating. Very few research articles voice the students' perspectives of CRP. Therefore, the purpose of this case study is to capture student perspectives of culturally relevant mathematics instruction for students participating in a culturally relevant mathematics intervention. The following two research questions were addressed in this research study: 1) what are African-American students' perspectives of culturally relevant mathematics instruction?; and 2) does culturally relevant instruction affect students' attitudes and interests toward mathematics?

Methodology

This case study explores African-American students' perspectives of culturally relevant mathematics instruction by engaging select attending a culturally relevant mathematics intervention in interviews. By listening to the "footsteps in the dark" (Howard, 2002), I hoped to understand the students feelings towards CRP in a mathematics classroom, and whether or not CRP is a preferred method of instruction over traditional instruction.

A culturally relevant intervention was taking place at Frankfort High School (pseudonym), an alternative high school located in a southern state, in which 37 students placed at-risk participated in culturally relevant mathematics instruction taught by myself, the researcher. Permission was granted by the school principal and school district to conduct the research at the site. The students participating in the study were taking a class to prepare for a mathematics state assessment and the researcher was allowed to teach the class for a 10-day period. The students that were selected to participate were given the option to attend the class or continue attending their regularly scheduled test preparation class. Although 37 students participated, because attendance was an issue at this particular school, there was a daily average of 20 students attending the class. The students participated in a pre- and post- assessment on the first and last day respectively, and they were given the option to be engaged in seven culturally relevant lessons on the topics of quadratic and exponential functions. One of the lessons extended over a two day period. The topics of the lessons included: 1) teen pregnancy (two lessons); 2) perinatal HIV; 3) teen smoking; 4) football and soccer; and 5) saving money. Students who participated in the culturally relevant intervention increased their mathematics performance on average by one letter grade.

Participants

All 37 of the students participating in the study were students placed at-risk by the school district. The demographics of the 37 students are included in Figure 6. The ages of the students ranged from 16-22. Parental and student consent forms were filled out for students 18 and under while only the student consent forms were completed by any students over the age of 18.

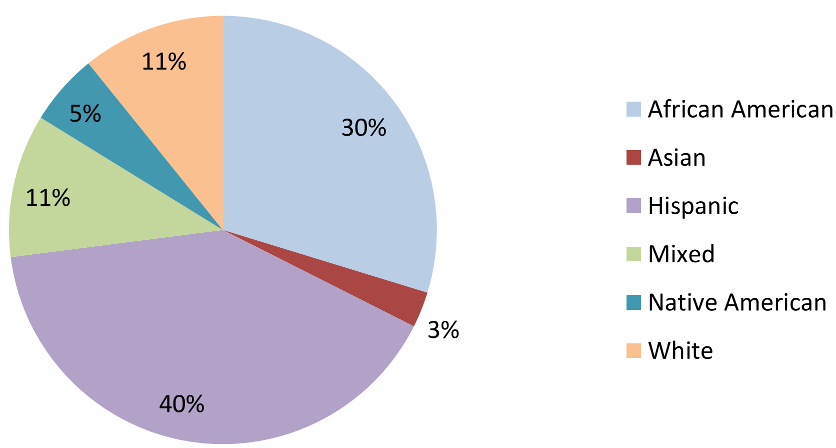

Figure 6. Demographics of the 37 students participating in the culturally relevant mathematics intervention.

Five students were selected to participate in semi-structured interviews. The five students were selected based on three criteria: 1) difference in pre- and post-assessment; 2) attendance; and 3) ethnicity. I wanted to include students with varying levels of achievement in the intervention in order to capture different perspectives; therefore, I sought to interview one of each of student whose difference from pre- to post-assessment: 1) score decreased the most; 2) score decreased moderately; 3) score was practically unchanged; 4) score moderately increased; and, 5) score increased the most. I also only included students who attended at least half of the hours of instruction. There were a total of 16 hours of instruction (eight two hour periods). Thus, the five students selected to participate in the interviews attended at least eight hours of instruction. Also, the purpose of the study was to capture African-American students' perspectives of culturally relevant instruction, but I also wanted to understand if other students felt the same way or different than African-American students. Therefore, I included at least two African-American students and at least two students from different ethnicities. A description of the five selected students is presented in Table 9.

Table 9

Interview Participant Characteristics

Name	Ethnicity & Gender	Difference in Pre-Post	# of Hours of Instruction
Student 1	African-American Female	-25	12
Student 2	Bi-Racial Female	-12	12
Student 3	White Female	+12	10
Student 4	African-American Male	+13	11
Student 5	Hispanic Female	+34	8

+ indicates an increase in scores and – indicates a decrease in scores

A White male was originally selected to participate in the interview whose score was practically unchanged (+2), but he was absent on the day interviews were conducted. Hence, I had to replace him with a student with similar characteristics. While all three selection criteria were important the ethnicity was paramount to gain perspective for White students which led to the selection of Student 3. Student 3 differed by gender and difference in score. Interviews were scheduled to be conducted on the last day which was also the day students took the post-assessment; however, students took longer than expected on the post-assessment which required me to get permission to return to the site on a different day to conduct interviews. The students were taking all of their state standardized assessments the week following the end of the intervention. Therefore, I returned to conduct interviews two weeks after the end of the intervention.

Data Collection

The semi-structured interviews were the data collected for this case study. The interviews were conducted by the researcher at the end of the intervention addressing the following questions 1) Before beginning the mathematics intervention, how did you feel about mathematics?; 2) How do you feel about mathematics now?; 3) How does the mathematics taught to you during the intervention compare to the type of mathematics instruction you receive in your regular mathematics class?; 4) Which of these two methods of instruction do you prefer, and why?; and 5) Which of these two methods of instruction helped you to understand and learn mathematics better, and why? All of the data collected were analyzed to capture the students' perspectives and attitudes toward culturally relevant mathematics instruction.

Data Analysis

The three analysis strategies presented by Creswell (2007) were used in the data analysis process. They included:1) preparing and organizing the data for analysis; 2) reducing the data into themes through a process of coding; and 3) presenting the data in figures, tables, or a discussion. The interviews were audio recorded and were prepared for analysis by transcribing them verbatim. The transcriptions of the interviews were analyzed to find common themes related to students' perspectives of culturally relevant mathematics instruction. Pre-existing codes guided the coding process. These codes were generated before the research was conducted from the existing literature that voiced African-American student perspectives on effective classroom environments. The codes include: 1) home-like classrooms; 2) ethic of caring; 3) participation opportunities; and 4) technology use. Although, I was looking to code data into these themes, I was also open to discovering new themes that existed in the data. Findings from the data are presented in a discussion and table.

Results

Overall the students had positive feelings towards culturally relevant mathematics instruction. All of the students interviewed stated that they prefer being taught mathematics using CRP versus the traditional method of instruction. One student even described traditional instruction as "grandma fashion" teaching while another student stated that using CRP "made the class feel so alive". All of the students interviewed also stated that participating in culturally relevant mathematics instruction helped to increase their interest in mathematics. All of the students interviewed made positive comments about participating in CRP which some are listed in Table 10. All of the positivity regarding CRP was attributed to one or more of the themes developed from the data.

Table 10

Student Perspectives of CRP

Student:	**Comment:**
Student 1	[CRP made it] "more easier" "I got it [the mathematics concepts] easier and faster" "It [CRP] made me like it [mathematics] more"
Student 2	"I felt like an idiot before I came to your class . . . but when I came to your class how you taught it [using CRP] I understood everything." "Thank you for opening my eyes" "It [CRP] was pretty fun"
Student 3	"It [CRP] did help . . . made it fun" "I really like it [CRP]. It was good and I think that it would help more kids."
Student 4	"It [CRP] helped me understand math better" "I felt happy, I felt like I actually wanted to be there and I actually wanted to learn math"
Student 5	"I understand a little bit more [since participating in CRP]"

Themes

The findings from the data were coded into the four pre-existing codes: 1) home-like classrooms; 2) ethic of caring; 3) participation opportunities; and 4) technology use. There were also two new codes developed from the data which were confidence and motivation. Therefore, the findings resulted in six themes. The first four themes (home-like classrooms, ethic of caring, participation opportunities, and technology use) contributed to the students' positive perspectives of CRP. The last two themes (confidence and motivation) were results of students participating in CRP.

In order for teachers to produce acceptable persons, teachers need intellectual capabilities and the ability to approach moral education from an ethic of caring perspective (1998). An ethic of caring involves acts done out of love and natural inclination and not out of duty (Noddings, 1988). The teacher responds to the needs, wants, and inclinations of the students. Ethic of caring entails modeling, dialogue, practice and confirmation (Noddings, 1988). Teachers' can model caring in many ways such as encouraging responsible self-affirmation in the students, being concerned about students' academic achievement, and being interested in the development of the fully moral person (Noddings, 1998). Caring teachers also model desirable ways to interact with people (Noddings, 1998). An ethic of caring involves teachers' allowing opportunities for dialogue between themselves and the students. In order for effective dialogue to take place, the teacher develops a relationship with the student that involves trust. Caring teachers also want their students to demonstrate caring through practice. The teacher promotes practice by encouraging students to support each other and providing opportunities for students to interact with other students in positive and productive ways. Confirmation involves confirming ethical acts committed by the student in order to shape the students' moral beliefs. An ethic of caring is concerned with the relations in which we all must live.

Home-Like Classrooms. Comments made by the students interviewed were consistent with findings from Howard (2001) in which students stated the ability of teachers to structure the classroom in a manner that resembled home was a strategy that made CRP teachers effective. Student 1 stated she felt smarter because the lessons dealt with issues related to her life and society which helped her understand the things that were going on in her home environment. Student 2 said she preferred CRP over traditional mathematics instruction because it involved using “real-life stuff”. She also stated that she could relate to the teen pregnancy lessons because her sister is a teenager and has two babies, and she could also relate to the teen smoking lesson because a lot of her friends were smokers. Therefore, she was more engaged in the lessons. Student 3 said she was interested in the topics of the lessons because they involved issues that many people experience at home today such as teen pregnancy and teen smoking. Student 3 even expressed how her mother gave birth to her while she was a teenager and how the lessons encouraged her to not want to follow in her mother’s footsteps. She stated “I want better for myself just like my mom wants better for myself.” Student 4 also enjoyed the topics because CRP helped him with both mathematics and understanding problems that he and his family experience at home. Student 5 voiced that because the instruction used life situations that she saw on a daily basis at home, she paid attention to what was going on in class, and therefore she learned more and understood mathematics better. Student 5 shared that using life situations in instruction made the class more interesting. She stated that it was not just life situations, but the fact that the life situations were issues that “nowadays kids need to learn about.” Overall, the fact that the lessons contained issues that students experienced at home contributed to students’ positive perspectives of CRP.

Ethic of Caring. CRP teachers' willingness to care about the students and their ability to bond with the students was noted as one of the most important features of an effective teacher in Howard's study (2001). Four of the students interviewed all shared a feeling about being cared for that helped them understand the concepts being taught better. This experience was the fact that I (teacher/researcher) took time out to make sure everyone understood the concept before going on to the next concept. The fact that I truly cared about the students and genuinely wanted them to understand the mathematical concepts led me to be patient with the students and really focus on their understanding versus making sure I finish the lessons which helped the students understand the concepts being taught. The following comments contributed to this conclusion:

- "You were like more step-by-step and like actually going back if nobody got it, going back and actually helping us through it." [Traditional teachers don't do this.] ~Student 1
- "[I like the way you teach because] if they [students] don't get it then you help them." ~Student 1
- [I understood mathematics better] "because you like talked, you did it step-by-step, and came to us one-on-one." ~Student 2
- "I need somebody to be kind of one-on-one and you went around the classroom going one-on-one with everybody." ~ Student 3
- "They [non-CRP teachers] are trying to hurry up and get things done, which you, you take time and if you don't really understand or get it, you

take out time to make sure you got us one-on-one and help us understand." ~Student 4

- "You would help us understand the first thing before you moved on to the next." ~Student 4

Student 3 also shared how the teacher being encouraging helped her to enjoy the culturally relevant instruction. Student 3 stated:

> "They [traditional teachers] don't like encourage students enough. You know alright they're [students] not going to do it so get out of my class that is basically how it is [in a traditional teacher's classroom]. So you know you're [teacher/researcher] like come on you can do this, like I'm a do it with you, and show you how to do it and go step-by-step and that's what helped me."

Student 4 shared that my [teacher/researcher] attitude and demeanor [a caring one] caused him to be comfortable to be in class. Student 4 shared with me one day during class that he typically skips class, but he attends my class because he feels wanted. He also shared that having a teacher who actually wants to help him learn mathematics helped him to "feel more encouraged and proud of himself for actually learning something." These comments made by Student 4 were consistent with Berry's (2005) findings that African-American males who were successful in mathematics stated that they came across a teacher who expressed care and provided encouragement and motivation that helped them to succeed. Student 4 also felt enough caring from me that he was compelled to tell me that he love me and thank me for taking the time out to work with him during the interview. Because I truly cared about the students it was manifested in many different ways, such as offering encouragement and motivation to the students. The students were able to feel the sincerity in me wanting to help, and as they noted, the ethic of caring made an influence on their mathematical learning. Meaningful student-teacher relationships have a positive impact on students' level of academic performance and their participation in mathematics courses (Brand et al., 2006).

Participation Opportunities. Two of the students shared how participation opportunities in the classroom helped contribute to their mathematical understanding. Student 1 preferred CRP over traditional instruction in learning mathematics because "you [teacher/researcher] gave everybody a chance to answer a question . . . [and when a student misunderstood a concept or got the answer wrong] you discussed that concept with everybody so everybody can know exactly what that person is talking about". Student 4 enjoyed working collaboratively as a class and in groups. He stated, "We worked together as a class more than we did by ourselves which really helped us understand a little bit more." Student 4 also shared that working in groups contributed to his increase in interest in mathematics because he was able to work with some of his friends, have fun, and learn all at the same time. These comments regarding effective CRP strategies are consistent with the feelings of African-American male students that effective classrooms are ones which allow them to actively participate in the learning process, work collaboratively in groups, and participate in student discourse (Moore, 2002).

Technology Use. During the intervention, the students used TI-84 calculators and computers with internet access. In this study, only one of the five students interviewed mentioned anything about technology use. Student 2 shared that her interest in mathematics increased after learning how to use the calculator. She expressed that learning how to do linear and quadratic regression, plot points, and evaluate functions at certain values changed her life and helped her to really understand mathematics more. Student 2 stated that using the calculator changed her perspective towards mathematics and commented "my calculator is truly my best friend now." Student 4's comments are consistent with findings from Liang and Zhou (2009) that technology use in the mathematics classroom increases students' learning of mathematics.

Confidence. Four of the five students discussed an increase in confidence. Student 1 expressed that participating in culturally relevant mathematics instruction helped her to "feel more confident" and "feel smart". Student 2 also shared, "I wasn't really a big fan of math and every since you [teacher/researcher] came I feel like I can take it on. Thank you!" Student 4 commented:

> "I feel more encouraged and you know I feel proud of myself that I'm actually learning something or some things that I thought I couldn't truly do when I said I couldn't do, but you helped me to understand them so it kind of changed me and the way I thought of my way of living."

Also, the class that I was teaching was a preparation course for the state standardized assessment. So in addition to students talking about an increase in confidence in mathematics overall, they also discussed an increase in confidence for taking the exam. As noted earlier, the interviews were conducted after students had taken the state standardized assessment. Below are some comments that students made in regards to the assessment.

- "But I think I did really good on the test [because I participated in the intervention]." ~Student 2
- "It [culturally relevant mathematics instruction] helped me for the test." ~Student 2
- "But I actually feel like I did better [on the test], because being in your class I know I didn't act like I listened a lot but it [culturally relevant mathematics instruction] did help." ~Student 3
- "I feel real good. I think I done really well on my math test. I never scored that high. You know I really think I passed my exit level [test because I attended your class]." ~ Student 4

Therefore, participating in culturally relevant mathematics instruction caused some of the students' confidence in mathematics to increase.

Motivation. All of the students interviewed discussed an increase in motivation. All of the students were motivated in a different way. Student 1 was motivated to make a difference in the lives of others. She stated that if she had time, she would go to middle schools and talk to them about some of the real life issues that were discussed as part of the CRP lessons. She said that she would share the truth with them and let them know what not to do and how to do it. Student 2 was motivated to make a difference in her own life. She shared how she was going to work towards stop smoking and take the necessary steps to not become a teen parent like her sister. Student 3 was motivated to work harder at studying mathematics. She stated that she wants to attend college after high school, and she realized that college mathematics will be more challenging which will require more work. Student 3 was also motivated to help other people who hated mathematics [like she used to] understand the mathematics concepts that she now understands. Student 4 was also motivated to make a difference in himself and his social circle. He stated that he was working on stopping smoking and not having sex and encouraging his friends to do the same. Student 4 stated, "[I will] tell my friends and sometimes myself I need to stop having so much sex because it is a lot of different diseases out here and telling myself and my friends that smoking is not cool . . . it [smoking] could cause a lot of damage." Finally, Student 5 was motivated to think about others' feelings when making decisions. Student 5 shared how she was touched by one of the videos watched in the CRP lessons in which the mother expressed how hurt she was because her teen daughters were pregnant. Student 5 stated watching this video made her realize that your decisions do not just affect you, but also others around you. All of the students felt motivated to make a difference in distinct ways after participating in culturally relevant mathematics instruction.

What are African-American students' perspectives of culturally relevant mathematics instruction? The two African-American students that participated in the interviews had very positive perspectives of culturally relevant instruction. Both of these students preferred CRP over traditional instruction. These two students also both expressed an increase in confidence from participating in culturally relevant mathematics instruction. They shared that participating in CRP created a desire in them to learn and motivated them to do better. These feelings were not different from the views of the other ethnic groups.

Does culturally relevant instruction affect students' attitudes and interests toward mathematics? All of the students interviewed expressed a positive change in their attitudes towards mathematics. The students commonly discussed how participating in CRP positively changed the way they felt about learning mathematics. Also, all of the students stated that participating in CRP increased their interest in mathematics. Therefore, culturally relevant instruction increased the students' interest in mathematics and positively changed their attitudes towards mathematics.

Discussion

The student interviews allowed the students an opportunity to voice their opinions towards culturally relevant pedagogy in a mathematics classroom. The interview gave the students a comfortable space to express what works and does not work for them in learning mathematics. One hundred percent of the students in the study felt positive about learning mathematics in a culturally relevant format and also voiced that culturally relevant instruction was the preferred method over traditional instruction. In the root of all the positivity of CRP for the students was the fact that CRP entailed classrooms that were similar to their home environment, contained caring teachers, provided opportunities for participation, and used technology. CRP also resulted in increased confidence and motivation for students that participated. Most of these findings are consistent with results from Howard (2001). The only new findings are the improved confidence in doing mathematics and the motivation to impact their world. The findings are not meant to be generalized but are particular for the sample of students interviewed. The results of the study can be used along with results from similar studies to more reliably predict students' perspectives of CRP.

The interviews revealed some very important insights to what works for African-American, as well as other students in learning mathematics. Having a classroom with a home-like environment piques the interest of the students to want to listen and pay attention. It also creates a comfortable environment where students feel welcome, more relaxed and willing to cooperate. Having a teacher that really cares about the students and their academic success causes the students to want to achieve more for themselves and for that teacher that genuinely cares. The teacher's confidence in the students' abilities transfers to the students and they themselves become more confident. Allowing students various opportunities to participate keeps the students engaged and gives them less time to do other things such as not pay attention are demonstrate behavior problems (Berry, 2005). Participation opportunities also give students an opportunity to grow and learn from each other. Using technology in a mathematics classroom provides multiple options for students to understand concepts. It also engages the students using a different mechanism. The insights that were revealed in this study can and should be used to improve mathematics education for African-American students.

Conclusion

We have heard the "footsteps in the dark", and now the question is what will we do with the footsteps? Will we let them stay in the dark, or will we lead them to the light? Letting the footsteps stay in the dark is hearing the voices of the students and doing nothing to change their circumstances in the mathematics classroom. Leading the footsteps to the light means to use the voices to better mathematics education for these students. The perspectives voiced lead to suggestions for teachers to create better classroom environments for African-American students. If teachers want to be successful with African-American students in mathematics, they can begin by genuinely caring for these students and their academic success. They can also create classrooms that resemble the homes of these students by using the culture of the students. These classrooms should also provide multiple participation opportunities for students and the use of technology. Although these suggestions may not be a cure-all, they are a starting point for creating positive educational reform for the mathematics education of African-American students.

CHAPTER V

CONCLUSION

Being a mathematics educator and a tutor almost all of my life has afforded me the opportunity to come across many African-American students, young and old, who have struggled with the subject of mathematics. After realizing that mathematics was a God given gift to me because it was something that I understood and enjoyed, I had a desire to help and make a broader impact. Therefore, this research began as a desire to improve mathematics education among African-American students. Not knowing exactly how, I began to search the literature for answers, and in the process I came across a book that changed my life. The title of that book was *The Dreamkeepers: Successful Teachers of African American Students* (Ladson-Billings, 2009). That book seemed to have all of the answers to what needed to be done. Therefore I began to read more of Ladson-Billing's work, and this is where I came to the knowledge of the theory of culturally relevant pedagogy (Ladson-Billings, 1995d). Ladson-Billings made me a believer of CRP, but one thing was missing for me and that was quantitative evidence. Therefore my mission in this study was to seek quantitative evidence that CRP really works in improving mathematics education for African-American students or to find an alternative that would, and to contribute evidence to the research bank.

My null hypotheses were already formulated in my head that there was no difference between CRP and traditional instruction. Also, because so many researchers recommended CRP as a strategy for improving mathematics education among African-American students (Brenner, 1998; Cooks, 1998; Ensign, 2003; Enyedy &

Mukhopadhyay, 2007; Gutstein et al., 1997; Ladson-Billings, 1995a, 1997; Langlie, 2008; Leonard, 2008; Leonard et al., 2005; Leonard & Guha, 2002; Leonard, Napp, & Adeleke, 2009; Matthews, 2003, 2008; Walker, 2009), I assumed that there would be a lot of evidence to support the recommendation. After conducting the meta-synthesis (Chapter II), I realized that there was not as much evidence that reported on the impact of CRP on African-American students mathematics performance as I thought it would be. Only seven documents reported on these impacts. Therefore my desire to contribute evidence to the research bank was needed. Although it was only a few documents, they were all rich in content. Analyzing the seven documents helped me to realize that CRP not only improved mathematics achievement, but also improved other aspects of learning for African-American students such as engagement in the learning process, life-skills, habits of student learning, general knowledge, and community advocacy. The culturally relevant intervention (Chapter III) was designed to accept or reject the hypothesis that I had formulated in my head, and just like I thought, I was able to reject the hypothesis formulated. In addition to rejecting the hypothesis, I also discovered that not only did African-American students benefit from CRP, but all students benefitted. Therefore, all students gained more than just an increase in mathematics scores from participating in CRP, but also gained knowledge and skills that will help further their education and help them to become successful citizens in a democratic society.

My qualitative research questions were how do African-American students feel about culturally relevant mathematics instruction and would their participation increase their interest in mathematics? The voices of the students were necessary to determine the solutions to the questions. Therefore, the case study (Chapter IV) was designed to hear the voices and perspectives of the students toward culturally relevant mathematics instruction. Although I did not get a chance to interview all students, there was a common consensus among the five students that were interviewed. They all felt very positively about culturally relevant mathematics instruction and CRP positively changed their attitudes and interests towards mathematics. One thing that I learned from this study was that the feelings were the same for all students regardless of ethnicity. Conducting this case study helped me to understand some particular aspects of culturally relevant instruction that created the positive changes and perspectives in the students. These aspects of CRP included caring teachers, home-like classroom environments, participation opportunities (in the classroom), and technology use (in the classroom). These were the common aspects of culturally relevant mathematics instruction that the students voiced perspectives on most frequently. Also, I believed that CRP would change the students' attitudes and interests towards mathematics, but conducting the case study also revealed that CRP helps to increase student confidence and motivation. Therefore, listening to the students voices helped me to truly understand how the students in this study felt about culturally relevant instruction.

Intellectual Merit and Broader Impacts

Given the current state of African-American students' mathematics achievement (Kober, 2010; Ladson-Billings, 1997), there is a need to seek improvement to the ways in which mathematics is taught to them. This study contributes to the need by investigating impacts of one particular recommendation for improving mathematics education among African-American students, using culturally relevant mathematics instruction. This study advances knowledge and understanding on culturally relevant mathematics instruction and the impacts it has on African-American students learning of mathematics. Although mathematics is the sole content focus of the study, it has the potential to convince content specialist in other areas to consider investigating CRP and the impacts it may have in their related field. My background in mathematics and my ethnicity has qualified me to lead this study. I am a doctoral candidate with a Bachelor and Master of Science in mathematics. I have six years of teaching experience at the college level, four years of working with K-12 students through Making Awesome Things Happen (M.A.T.H.) nonprofit organization, and 11 years of professional tutoring experience at all levels. I am an African-American female which creates in me a genuine desire to help African-Americans to be successful in mathematics. I wrote all of the culturally relevant mathematics lessons implemented in this study, and designed them specifically to fit the students participating. The study was well designed and critiqued by a wonderful committee of experts.

Investigating the impacts of CRP on African-American students' mathematics achievement promotes teaching, training, and learning. Numerous mathematics teachers desire ways to help their African-American students succeed. This research provides one solution to improving mathematics performance for these students. If teachers are truly interested in implementing CRP, then they need to be trained in it, therefore this study also promotes training. The greatest of the three that is promoted is learning. Participating in culturally relevant mathematics instruction provided multiple learning opportunities for students participating. Students were able to learn mathematics, life skills, transferrable habits of learning, general knowledge, and how to be advocates in their community. Hence, the broader impacts of studying culturally relevant mathematics instruction include promoting teaching, training, and learning.

This study also contributes to broadening the participation of underrepresented groups; in this case, African-American students. Helping African-American students to succeed in mathematics allows them opportunities to have full participation in science, technology, engineering, and mathematics (STEM). The findings of this study help to improve STEM education which results in the development of a more diverse, globally competitive STEM workforce. African-American students will be able to take on these STEM fields without having that fear of mathematics. Therefore, also resulting in increased economic competitiveness for the United States. Thus, the impacts of this study extend beyond just the students in the study. The findings have the potential to change the lives of many.

Recommendations for Future Research

The present study answered numerous questions in regards to the students in this study that participated in culturally relevant mathematics instruction. The results of this study cannot be generalized to all students, and therefore, more research needs to be conducted to contribute to the database of research on CRP in a mathematics classroom. More research on the effects of mathematics CRP for various groups of students can be conducted in order to compare results across studies. In addition to the effects of mathematics CRP, the relationship between CRP and specific variables should also be studied such as attendance, length of instruction, student attitude, student confidence, behavior, and gender. More research on this topic would be a starting place for creating change within mathematics classrooms across the country. Notice that the research is only a starting place, and must be followed up with a connection of research to practice.

Recommendations for Future Practice

Implementing culturally relevant pedagogy in a mathematics learning environment demonstrated positive effects for various groups of students in this study and other studies discussed within the body of this study. Therefore, in addition to further research on more in-depth relationships of culturally relevant pedagogy and mathematics, teachers should begin implementing CRP in mathematics classrooms. In order for implementation to take place, teachers need to be educated about CRP and its possible impacts. I recommend that future practice of CRP be promoted through three avenues: professional development, conferences, and teacher preparation programs.

In recent attempts at educational reform, professional development has been essential in improving learning and achievement (Loucks-Horsley & Matsumoto, 1999). Professional development has the ability to produce multiple outcomes such as teacher learning of new knowledge and teaching skills, changes in classroom practice, implementation of new curriculum or assessment programs, and changes in school and district culture (Loucks-Horsley & Matsumoto, 1999). Research has shown that if schools, districts, and states are supportive, then when teachers make changes in their practice due to information learned from professional development, students' learning can be improved (Loucks-Horsley & Matsumoto, 1999). Therefore, professional development is recommended as one avenue through which to inform teachers on general information related to culturally relevant pedagogy. In addition, professional development should aim to demonstrate how to implement mathematics CRP, and provide continuous support to teachers in implementing lessons within their classrooms. This particular recommendation for professional development is one that is targeted specifically toward improving student achievement in which some argue is the only worthwhile investment of funding professional development (Loucks-Horsley & Matsumoto, 1999).

Conferences provide a platform for researchers to share new and innovative ideas, and for others to learn about new practices within their field. There exist numerous educational conferences such as annual meetings of American Educational Research Association, National Council of Teachers of Mathematics, National Alternative Education Conference, National Association for Gifted Children, Benjamin Banneker Association, just to name a few. Any educational conferences that support improving mathematics education for students provide an avenue for CRP to be promoted in mathematics classrooms. These conferences provide opportunities for researchers to share information related to CRP such as general knowledge, effects on students, and process for implementation. Therefore, researchers can promote the practice of CRP by sharing CRP at multiple conferences.

Teacher preparation programs are designed to adequately prepare participants to become effective educators (Borman, Mueninghoff, Cotner, & Frederick, 2009). This includes preparing teachers to be able to address the changing needs of students who are becoming extremely diverse and grouped according to socioeconomic status (Borman, Mueninghoff, Cotner, & Frederick, 2009). Therefore, teacher preparation programs are another avenue in which CRP in mathematics classrooms can be promoted. CRP could be introduced as a topic in various courses such as courses related to multi-cultural classrooms, instructional strategies, diverse learners, or mathematics education. These courses could also help students to develop CRP lessons and provide opportunities for students to learn to effectively implement CRP in mathematics classrooms. Not only should traditional teacher preparation programs introduce CRP, but alternative teacher preparation programs should also provide training and practice in CRP to familiarize teachers with various options to promoting student achievement.

As a researcher, I know data does not always turn out the way you want it to, but I can honestly say that I am very pleased with the results of these studies. All three studies have supported the recommendations for using CRP in a mathematics classroom to improve achievement for African-American students. The studies have also added valuable information and insights that I never thought of before. For example, using CRP promotes more than mathematics achievement, but also improves attitudes, confidence, motivation, engagement, and community involvement. The question to address now is where do we go from here? Is this just another dissertation to add to the database of numerous other dissertations? Or, will this be a dissertation used to cause changes in our educational system? The answer is up to you. Whatever you decide to do with the information you have received in this study will determine the answer to that question. I, on the other hand, plan to share CRP with other mathematics educators. I want to inform people on the definition of CRP, and how to utilize it in the mathematics classroom. I want to use the results of this study to show educators that CRP works! I want to always use CRP in any class that I may teach. I want to make sure that this dissertation is not just another dissertation to contribute to the database, but is one that is used to make changes in the mathematics education for African-American students. In the words of deceased singer Sam Cook, “A change is gonna come”!

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APPENDIX A

Lesson 1

Title of Lesson: Teen Pregnancy and Quadratics

Topic or Main Idea: Introduction to quadratic functions and teenage pregnancy rates for 15-19 year olds from 1985 to 2004.

Objectives:

1) Students will be able to identify quadratic functions symbolically.
2) Students will be able to describe the relationship between the independent and dependent variable.
3) Students will be able to convert from numerical to symbolic forms of quadratic functions.
4) Students will become more aware of teen pregnancies and the effects it have on families.
5) Students will identify and discuss the social inequities in teen pregnancies.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

(A) apply mathematics to problems arising in everyday life, society, and the workplace;

(B) gather and record data and use data sets to determine functional relationships between quantities;

(D) represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities; and

(E) create and use representations to organize, record, and communicate mathematical ideas;

(8) Quadratic functions and equations. The student applies the mathematical process standards to solve, with and without technology, quadratic equations and evaluate the reasonableness of their solutions. The student formulates statistical relationships and evaluates their reasonableness based on real-world data. The student is expected to:

(B) write, using technology, quadratic functions that provide a reasonable fit to data to estimate solutions and make predictions for real-world problems.

Algebra II

(4) Quadratic and square root functions, equations, and inequalities. The student applies mathematical processes to understand that quadratic and square root functions, equations, and quadratic inequalities can be used to model situations, solve problems, and make predictions. The student is expected to:

(A) write the quadratic function given three specified points in the plane;

Materials:

Access to computer, projector, and internet

Teenage Pregnancy Worksheet

Teenage Pregnancy Rate Table

Graphing Calculator

Teen Pregnancy Practice Problems

Calculator Assistance Handout

Activity:

1) Teacher will present Youtube video about teen pregnancy to the class: http://www.youtube.com/watch?v=YHennhq1cMg (10 minutes)
2) Teacher will engage students in conversation about teen pregnancies. (5 minutes)
3) Teacher will give worksheet to students. Teacher can instruct students to use their smart phones to visit the following site to view data on teen pregnancies or the table can be printed and distributed to students. Depending on time, teacher can have students do their own research and look up pregnancy rates for different ethnicities from about 1980 to 2005 for 15-19 year olds. Link: http://nces.ed.gov/pubs2007/minoritytrends/tables/table_21.asp?referrer=report (15 minutes)
4) Students will have to record their data from the chart onto a table.
5) Teacher will walk through plotting the years versus the teen pregnancy rate of 15-19 year olds from 1985-2004 for all Americans. Have students walk through with you. (10 minutes)
6) Students will then create their own plot according to their ethnicity. (10 minutes)
7) Teacher will ask students open ended questions about the shape of the plotted points, which are all very U-shaped except for Hispanics. The plot for Hispanics is not as obvious as the other ethnicities and some students may say that it is linear. In this case the teacher can show students how to do linear regression. (10 minutes)
8) Teacher will introduce quadratics functions and its relationship to the U-shape without going into detail about the graphs, since lesson two will go into further depth about the graphs of quadratic functions. Teacher will briefly describe independent and dependent variables and how to read the graphs. (10 minutes)
9) Teacher will walk the students through quadratic regression in order for the students to obtain the quadratic function for their ethnicities. The teacher will ask open ended questions to get the students thinking about how the formula is used. The questions should lead to students being able to identify the independent and dependent variables, and students being able to evaluate the function at different values. (20 minutes)
10) Teacher will engage students in a conversation about the social inequities that exist among teenage parents. What are the students' perspectives? How can they avoid being in this social group? What can we do as a society to minimize the social inequities that exist?

11) Conclude by having students do the three homework questions. The teacher can also show the graphs in the following link of the most current teenage pregnancy rate trends: http://www.cdc.gov/teenpregnancy/aboutteenpreg.htm

Homework: Teen Pregnancy Practice Problems

Calculator Assistance for Teen Pregnancy Lesson

Steps to Plotting the Data:

1) Select **STAT** and **1**.Down the L1 column, list all of your X-Values. Down the L2 column list all of your Y-Values.
2) Select **Y=** and clear anything that is listed after Y=. Move the cursor until it is on PLOT1 and select **ENTER**.
3) Select **GRAPH**.
4) Select **ZOOM** and **9**.

Steps to Quadratic Regression:

1) Select **2nd , Quit** and then select **STAT**.
2) Use the right cursor to get to **CALC** and select **5**.
3) Select **2nd , STAT, 1,** and press **the comma.**
4) Select **2nd , STAT, 2,** and press **the comma.**
5) Select **VARS,** use the right cursor to go over to **Y-VARS**, and **1, 1**.
6) Select **ENTER**.

Steps to Look at the Table:

1) Select **2nd , GRAPH**.
2) If you need to change the values in the table, select **2nd , WINDOW.**

Lesson 2

Title of Lesson: Teen Pregnancy and Quadratics, Part 2

Topic or Main Idea: Exploring the graphs of quadratic functions.

Objectives:

1) Students will be able graph quadratic functions by hand and calculator.
2) Students will be able to describe and identify the parent function of quadratic functions.
3) Students will be able to read the graphs of quadratics.
4) Students will be able to identify and describe the domain and range of the graphs of quadratic functions.
5) Students will identify and discuss the trends in throughout history teen pregnancies.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(2) Foundations for functions. The student uses the properties and attributes of functions. The student is expected to:

(A) identify and sketch the general forms of linear (y = x) and quadratic (y = x2) parent functions;

(B) identify mathematical domains and ranges and determine reasonable domain and range values for given situations, both continuous and discrete;

(C) interpret situations in terms of given graphs or creates situations that fit given graphs;

(9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and

describe the effects of changes in the parameters of quadratic functions. The student is expected to:

(A) determine the domain and range for quadratic functions in given situations;

(D) analyze graphs of quadratic functions and draw conclusions.

Algebra II

(1) Foundations for functions. The student uses properties and attributes of functions and applies functions to problem situations. The student is expected to:

(A) identify the mathematical domains and ranges of functions and determine reasonable domain and range values for continuous and discrete situations;

(4) Algebra and geometry. The student connects algebraic and geometric representations of functions. The student is expected to:

(A) identify and sketch graphs of parent functions, including linear (f (x) = x), quadratic (f (x) = x^2),

Materials:

Access to computer, projector, and internet

Teenage Pregnancy Worksheet #2

Graphing Calculator

Teen Pregnancy Practice Problems #2

Activity:

1) Review quadratic regression and evaluating quadratic functions with the calculator. Also review independent and dependent variables. (15 minutes)

2) Teacher will present YouTube video about cycles of teen pregnancy to the class: http://www.youtube.com/watch?v=ys4FEFphRYE (5 minutes)
3) Teacher will engage students in conversation about teen pregnancies. (5 minutes)
4) Students will graph the equation that was generated from lesson 1 for the overall teen pregnancy rate. Teacher will engage students in a conversation about the trend in the graph. The objective in this conversation is to get students to read the graph of the quadratic function. Teacher will also introduce terms such as parabola, vertex, max or min, without going into full details about those terms because they will be further explored in lesson 4 (the function is included on the worksheet). (10 minutes)
5) Teacher will briefly describe domain and range and engage students in a conversation about domain and range leading up to students being able to identify the domain and range of quadratic functions. (10 minutes)
6) Teacher will briefly describe the parent function for quadratic functions and guide students into graphing the parent function. (20 minutes)
7) Students are guided into a conversation discussing trends in the parent function. Students are also led into a conversation discussing the domain and range of the parent function. (10 minutes)
8) Teacher will engage students in a conversation about the social inequities that exist among teenage parents. See if the students can brainstorm any additional social inequities that exist among teen parents that were not brainstormed in the first lesson. (5 minutes)
9) Depending upon time restraints, have students research what happened after 1991 that caused the teen pregnancy rate to begin to decline.

Homework: Teen Pregnancy Practice Problems #2

Extension: Have students design a campaign to promote teen pregnancy awareness and safe sex. Require students to use quadratic functions in the campaign.

Teenage Pregnancy Worksheet #2

Name: ____________________________________

Date: ____________

1) What stood out of interest to you in the second teen pregnancy video?

2) From the first lesson, the quadratic function generated for the teen pregnancy rates for all ethnicities was: $\boldsymbol{f(x) = -.092x^2 + 1.694x + 51.068}$
   Graph the function on your graphing calculator and briefly sketch the graph below labeling your x- and y-axis.

3) Describe what is happening to the graph over time.

4) When did the graph begin to change? What do you think caused this change?

5) What is the domain of the function graphed in number 2?

6) What is the parent function for quadratic functions?

7) Complete the chart below for the parent function by selecting values of the independent variable to evaluate.

X	**Y**

8) Sketch the graph of the parent function below.

9) Describe the trend in the graph of the parent function. Does it have a maximum of minimum?

10) What is the domain of the parent function?

11) What is the range of the parent function?

12) A **Social inequality** refers to a situation in which individual groups in a society do not have equal social status, social class, and social circle. What are some social inequities that exist with teenage parents that you did not list in lesson 1?

13) What are some ways you can inform your peers about teen pregnancy prevention?

Lesson 3

Title of Lesson: Perinatal HIV Infections in the United States

Topic or Main Idea: Transformations of quadratic functions.

Objectives:

1) Students will be able to identify and apply vertical transformations to quadratic functions.
2) Students will be able to identify and apply vertical stretches and shrinks to quadratics functions.
3) Students will be able to identify and apply reflections about the x-axis to quadratic functions.
4) Students will have an understanding of perinatal HIV infections.
5) Students will be able to identify, recognize, and critique the social inequities involved in HIV infection.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(1) Foundations for functions. The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways. The student is expected to:

(B) gather and record data and use data sets to determine functional relationships between quantities;

(C) describe functional relationships for given problem situations and write equations or inequalities to answer questions arising from the situations;

(D) represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities; and

(E) interpret and make decisions, predictions, and critical judgments from functional relationships.

(9) Quadratic and other nonlinear functions. The student understands that the graphs of quadratic functions are affected by the parameters of the function and can interpret and describe the effects of changes in the parameters of quadratic functions. The student is expected to:

(B) investigate, describe, and predict the effects of changes in a on the graph of $y = ax^2 + c$;

(C) investigate, describe, and predict the effects of changes in c on the graph of $y = ax^2 + c$;

(D) analyze graphs of quadratic functions and draw conclusions.

Algebra II

(1) Foundations for functions. The student uses properties and attributes of functions and applies functions to problem situations. The student is expected to:

(B) collect and organize data, make and interpret scatterplots, fit the graph of a function to the data, interpret the results, and proceed to model, predict, and make decisions and critical judgments.

Materials:

Access to computer, projector, and internet

Perinatal HIV-Infected Infants Table

Graphing Calculator

Perinatal HIV-Infected Infants Worksheet

Activity:

1) Review terminology from lesson 2. (5 minutes)
2) Teacher will present two YouTube videos. The first one is general information about HIV/AIDS and the second is stories from HIV infected people (10 minutes):
   http://www.youtube.com/watch?v=P91nIGt1axs

   http://www.youtube.com/watch?v=COfdnY27LP4

3) Students will answer questions 1-3 related to the videos. (5 minutes)
4) Students will record the data from the Number of HIV Infected Infants Table from year 1985 to 1998. (5 minutes)
5) Students will determine the type of function by observing the shape. Students will use regression to determine the function that best fits the data. (10 minutes)
6) Teacher will lead the students into a discussion about the trend in the graph. (10 minutes)
   Teacher will show another YouTube video:

   http://www.youtube.com/watch?v=XK4DrK9GqhU

7) Teacher will engage students in a conversation about changing the values of c in the function. What does it do to the graph? What would that mean for the number of cases of HIV infected infants?
8) Teacher will engage students in a conversation about changing the values of a in the function. What does it do to the graph? What would that mean for the number of cases of HIV infected infants? Teacher will also engage students in a conversation about vertical reflections.
9) Teacher will engage students in a conversation about changing the values of a and c together in the function.
10) Teacher will engage students in a conversation about the social inequities that exist among people who received HIV at birth. (5 minutes)

Homework: Vertical Transformations Practice Problems

Extension: Have students read the following article about the discrepancies among ethnicities and perinatal HIV infections.

http://www.aidsbeacon.com/news/2010/02/11/new-statistics-released-by-the-cdc-show-continued-ethnic-and-racial-disparities-among-perinatal-hiv-infection-rates/

Have students design an awareness campaign of perinatal HIV prevention medications.

Resources: Center for Disease Control and Prevention

HIV Infected Infants Worksheet

Name: ____

Date: _____________

1) What are ways HIV/AIDS is passed?

2) How can you be tested for HIV?

3) What is perinatal HIV?

4) List the data in the table below for the number of HIV infected infants between the years of 1985 to 1998.

Year	X	Y
1985		
1986		
1987		
1988		
1989		
1990		
1991		

Year	X	Y
1992		
1993		
1994		
1995		
1996		
1997		
1998		

5) Briefly sketch the shape of your plot below.

6) What is the shape of the points? What type of function does the data represent?

7) Conduct a regression to find the values for a, b, and c. Round to the nearest hundredth.

   a = ______________________

   b = ______________________

   c = ______________________

8) Write the quadratic function substituting in the values for a, b, and c.

9) Change the value of c to ________, and rewrite the function.

10) Graph the functions in numbers 8 and 9 together. What happened to the graph?

11) Change the value of c to _______, and rewrite the function.

12) Graph the functions in 8 and 11 together. What happened to the graph?

13) Change the value of a to _______, and rewrite the function.

14) Graph the functions in 8 and 13 together. What happened to the graph?

15) Change the value of a to _______, and rewrite the function.

16) Graph the functions in 8 and 15 together. What happened to the graph?

17) Change the value of a to _______, and rewrite the function.

18) Graph the functions in 8 and 17 together. What happened to the graph?

19) A **Social inequality** refers to a situation in which individual groups in a society do not have equal social status, social class, and social circle. What are some social inequities that exist with people who received HIV at birth? What are some things that you can do to prevent these inequalities?

Lesson 4

Title of Lesson: Teen Tobacco Use

Topic or Main Idea: Properties of Graphs of Quadratic Functions

Objectives:

1) Students will be able to identify the vertex of a parabola.
2) Students will be able to identify the axis of symmetry of a parabola.
3) Students will be able to identify the maximum or minimum of a parabola.
4) Students will be able to identify the zeros from looking at the graph of a parabola.
5) Students will have an understanding of tobacco use and its effects.
6) Students will be able to identify, recognize, and critique the social inequities involved in teen tobacco use.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(1) Foundations for functions. The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways. The student is expected to:

(B) gather and record data and use data sets to determine functional relationships between quantities;

(C) describe functional relationships for given problem situations and write equations or inequalities to answer questions arising from the situations;

(D) represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities; and

(E) interpret and make decisions, predictions, and critical judgments from functional relationships.

(10) Quadratic and other nonlinear functions. The student understands there is more than one way to solve a quadratic equation and solves them using appropriate methods. The student is expected to:

(A) solve quadratic equations using concrete models, tables, graphs, and algebraic methods; and

(B) make connections among the solutions (roots) of quadratic equations, the zeros of their related functions, and the horizontal intercepts (x-intercepts) of the graph of the function.

Algebra II

(1) Foundations for functions. The student uses properties and attributes of functions and applies functions to problem situations. The student is expected to:

(B) collect and organize data, make and interpret scatterplots, fit the graph of a function to the data, interpret the results, and proceed to model, predict, and make decisions and critical judgments.

(6) Quadratic and square root functions. The student understands that quadratic functions can be represented in different ways and translates among their various representations. The student is expected to:

(A) determine the reasonable domain and range values of quadratic functions, as well as interpret and determine the reasonableness of solutions to quadratic equations and inequalities;

(B) relate representations of quadratic functions, such as algebraic, tabular, graphical, and verbal descriptions; and

(C) determine a quadratic function from its roots (real and complex) or a graph.

Materials:

Access to computer, projector, and internet

Tobacco Use Table -

http://www.oas.samhsa.gov/NSDUH/2k10NSDUH/2k10Results.htm#LOT

Teen Smoking Quiz -

http://www.intelihealth.com/IH/ihtIH/WSIHW000/22017/24554/339536.html?d=dmtCo
ntent

Graphing Calculator

Activity:

1) Review terminology and concepts from lesson 3. (5 minutes)
2) Give students the Teen Smoking Quiz. (10 minutes):
3) Discuss the results from the quiz. (5 minutes)
4) Display the table of teen cigarette use and have students come up with the function that fits the graph. (5 minutes)
5) Display the table of marijuana use and have students come up with the function that fits the graph. (10 minutes)
6) Teacher will lead the students into a discussion about the trend in the graphs. Teachers will also lead the students into a discussion about the comparison of these two graphs with the previous graphs of teen pregnancies and perinatal HIV. (10 minutes)
7) Teacher will engage students in a conversation about maximum, minimum, and vertex.
8) Teacher will engage students in a conversation symmetry and axis of symmetry.
9) Teacher will engage students in a conversation about determining when there will be no teens smoking cigarettes or marijuana according to the graphs. This conversation will lead into a discussion about identifying the zeros/roots from the

graph. The graphs on tobacco use will not have any zeros, therefore teacher will need to return to the graphs of the teenage pregnancies and/or perinatal HIV rates.

10) Teacher will engage students in a conversation about the effects of tobacco use. (5 minutes)
11) Teacher will engage students in a conversation about social inequities that exist within teen tobacco use. Teacher will also engage students in a conversation about teen tobacco use prevention.

Homework: Properties of Parabolas Practice Problems

Extension: Have students create commercial advertisements in groups for youth tobacco use prevention.

Lesson 5

Title of Lesson: Learning to Speak Algebra

Topic or Main Idea: Simplifying Algebraic Expressions

Objectives:

1) Students will be able to combine like terms.
2) Students will be able to use the distributive property to simplify algebraic expressions.
3) Students will understand what it means to simplify.
4) Students will be able to multiply binomials.
5) Students will understand order of operations.
6) Students will be able to define, discuss, and demonstrate algebra terms.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(4) Foundations for functions. The student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the necessary algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations. The student is expected to:

(A) find specific function values, simplify polynomial expressions, transform and solve equations, and factor as necessary in problem situations;

(B) use the commutative, associative, and distributive properties to simplify algebraic expressions;

Algebra II

(2) Foundations for functions. The student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the necessary

algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations. The student is expected to:

(A) use tools including factoring and properties of exponents to simplify expressions and to transform and solve equations;

Materials:

Access to computer, projector, and internet

Small White Boards (OR index cards OR construction paper)

Computer Access for each student

Activity:

1) Review terminology and concepts from lesson 4. (5 minutes)
2) Teacher will lead the students in a conversation about simplify and what students think it mean. Also teacher will engage students in a conversation about like terms. (10 minutes)
3) Teacher will give the students the option to choose one of the following terms: x, y, xy, x^2, 8, -2, 5 (2 minutes)
4) Students will write their chosen terms on their white board. Teacher will inform students that chose x, y, xy, x^2 to put a coefficient in front of their term. The teacher will write all terms on the board. (3 minutes)
5) Students will be instructed to get up and find other people in the room that have terms like their term. (5 minutes)
6) Once students combine their terms, teacher will instruct the students to arrange the terms in standard form, without telling them the definition of standard form, but giving them the option to use the computers to look it up. Teacher can encourage students to use their smartphones if they are allowed, but teacher will need to closely monitor to make sure students are not doing more than looking up terms on their phones. (10 minutes)
7) If time permits, teacher can repeat the activity by having students choose another term. (About 20 minutes to repeat activity)
8) Teacher will engage the students in a conversation about how to go to college. The purpose of this conversation is to get students to understand that there is a process that must be taken. Teacher will guide students from this conversation

into a conversation about order of operation, relating the process of order of operations to the process of going to college. (10 minutes)

9) Teacher will ask students what is the distributive property? Allowing students to use the computers to research. Teacher will call on students to have them explain the definition and give an example of how it works. (10 minutes)
10) Teacher will allow students to go to the following website to practice using the distributive property (10 minutes): http://www.mangahigh.com/en_us/maths_games/algebra/simplifying_algebra/multiply_a_bracket_by_a_term
11) Teacher will engage students in a conversation about multiplying binomials, by first asking students what is a binomial? Asking students these questions and having them look it up helps students to learn to take responsibility of their own learning. (5 minutes)
12) Teacher will pair the students and give each pair a binomial to multiply, but the group must figure out how to multiply the binomial on their own. (10 minutes)
13) Each pair will present what they found, and demonstrate how they multiplied their binomial. (15 minutes)

Homework: Practice problems combining all of the various aspects discussed throughout the lesson.

Resources:

Ideas from some of this lesson came from

http://ispeakmath.wordpress.com/2012/10/02/simplifying-algebraic-expressions-activity/

Lesson 6

Title of Lesson: Football and Fútbol

Topic or Main Idea: Solving Quadratic Equations

Objectives:

1) Students will understand the concept of projectile motion.
2) Students will understand the purpose of finding roots.
3) Students will know how to use the quadratic formula.
4) Students will know how to solve quadratic equations using the quadratic formula

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(4) Foundations for functions. The student understands the importance of the skills required to manipulate symbols in order to solve problems and uses the necessary algebraic skills required to simplify algebraic expressions and solve equations and inequalities in problem situations. The student is expected to:

(A) find specific function values, simplify polynomial expressions, transform and solve equations, and factor as necessary in problem situations;

(10) Quadratic and other nonlinear functions. The student understands there is more than one way to solve a quadratic equation and solves them using appropriate methods. The student is expected to:

(A) solve quadratic equations using concrete models, tables, graphs, and algebraic methods; and

(B) make connections among the solutions (roots) of quadratic equations, the zeros of their related functions, and the horizontal intercepts (x-intercepts) of the graph of the function.

Algebra II

(8) Quadratic and square root functions. The student formulates equations and inequalities based on quadratic functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation. The student is expected to:

(A) analyze situations involving quadratic functions and formulate quadratic equations or inequalities to solve problems;

(B) analyze and interpret the solutions of quadratic equations using discriminants and solve quadratic equations using the quadratic formula;

(C) compare and translate between algebraic and graphical solutions of quadratic equations; and

(D) solve quadratic equations and inequalities using graphs, tables, and algebraic methods.

Materials:

Access to computer, projector, and internet

Graphing Calculators

Football and Soccer Ball

Football and Fútbol Worksheet

Roles and Duties Sign Up Sheet

Activity:

1) Students will sign up for assigned task. Task include: 2 quarterbacks, 2 timers, 4 ball receivers, 2 kickers. These tasks can be adjusted depending on class size. Some people can share duties or there can be more trials. There will be two football and 2 soccer trials in this particular experiment (5 minutes)
2) Teacher will lead the students in a conversation about projectile motion, allowing students the opportunity to look it up and explain what they think it is. Also have students find the quadratic function associated with projectile motion and make sure the students are able to explain what the variables and constants represent (10 minutes).
3) Inform students that the task is to see who can throw the football the highest and who can kick the soccer ball the highest. Students will go outside and perform their tasks. Students need to observe the task and choose whose balls they think went the highest. On the worksheet is an option for students to choose a sport, and students will only select whose ball went the highest for that sport. This option can be modified and students can actually choose for both sports if desired by teacher.
4) The recorder need to make sure that he/she records the times that the timer calls out.
5) Students will sketch the path of the ball and they should notice that the balls follow a parabolic path, and is considered to be projectile motion. Students should be able to make this connection on their own.
6) Students need to determine the initial height of the ball. Students also need to record the time for the person they thought had the highest throw or kick.
7) Show students how to use the function for projectile motion to generically solve for the initial velocity, and have students calculate the initial velocity for the ball they chose.
8) Students now have enough information to write the function for the path of their chosen ball.
9) Students need to understand what they are looking for if they want to find how high the ball went, and they need to calculate the maximum height of the ball they chose.
10) Teacher will generate discussion about the quadratic formula to see if they know it. If they don't know it, have them look it up. Teacher may share any mnemonics for the quadratic formula.
11) Students will use the quadratic formula to calculate the zeros of the function they wrote in number 9.

12) Generate discussion about what the variable t represent in solving the quadratic equation. Students should be able to make connections and identify that these values of t include the length of time it took the ball to hit the ground.
13) Teacher will generate discussion about when the height of the ball would be important in football or soccer. Teacher will also generate discussion about social inequities that exist with the sports of football and soccer.

Homework: Practice problems of solving quadratic equations.

Roles and Duties Sign Up Sheet

Quarterback #1	
Quarterback #2	
Kicker #1	
Kicker #2	
Timer #1	
Timer #2	
Recorder	
Receiver	

Football and Fútbol Worksheet

Name: ______________________________________

Date: _____________

1) Choose a sport: Football or Fútbol

2) What is projectile motion?

3) What is the quadratic equation for projectile motion?

4) Whose ball do you think went the highest?

5) Sketch the path of the ball labeling the x and y axis

6) What was the initial height of the ball?

   s = ________ ft

7) How long did it take for the ball to hit the ground?

t = ________ sec

8) Calculate the initial velocity using the following formula:

9) Write the equation for the path of ball.

10) Find the maximum value.

11) Whose ball actually went the highest?

12) What is the quadratic formula?

13) Let h(t) = 0 and solve for t using the quadratic formula.

a = ______________

b = ______________

c = ______________

14) What does t represent?

15) Did you notice anything about the values of t?

16) When would you care how high the ball is in either of these sports?

17) What are some social inequities that exist in sports such as football and fútbol?

Lesson 8

Title of Lesson: Saving for the Dream Trip

Topic or Main Idea: Exponential Functions

Objectives:

1) Students will be able to write exponential functions from given information.
2) Students will be able to distinguish between exponential growth and decay functions.
3) Students will be able to evaluate exponential functions.
4) Students will have an understanding of savings and interest.

Standards Used (Texas Essential Knowledge and Skills):

Algebra I

(11) Quadratic and other nonlinear functions. The student understands there are situations modeled by functions that are neither linear nor quadratic and models the situations. The student is expected to:

(A) use patterns to generate the laws of exponents and apply them in problem-solving situations;

(C) analyze data and represent situations involving exponential growth and decay using concrete models, tables, graphs, or algebraic methods.

Algebra II

(11) Exponential and logarithmic functions. The student formulates equations and inequalities based on exponential and logarithmic functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation. The student is expected to:

(C) determine the reasonable domain and range values of exponential and logarithmic functions, as well as interpret and determine the reasonableness of solutions to exponential and logarithmic equations and inequalities;

(D) determine solutions of exponential and logarithmic equations using graphs, tables, and algebraic methods;

(F) analyze a situation modeled by an exponential function, formulate an equation or inequality, and solve the problem.

Materials:

Access to computer, projector, and internet

Graphing Calculators

Saving for the Dream Trip Worksheet

Activity:

1) Begin with the question of whether students will choose one million dollars or a penny doubled every day for 30 days. Have students make a decision, and engage the students in a conversation about which one they think is actually the most. Ask students how to determine how much they will have at the end of the 30 days. Have students walk through the payment schedule.
   Day 1: $.01

   Day 2: $.02

   Day 3: $.04

   Day 4: $.08

   Day 5: $.16

   Day 6: $.32

   Day 7: $.64

Day 8: $1.28

Day 9: $2.56

Day 10: $5.12

Day 11: $10.24

Day 12: $20.48

Day 13: $40.96

Day 14: $81.92

Day 15: $163.84

Day 16: $327.68

Day 17: $655.36

Day 18: $1,310.72

Day 19: $2,621.44

Day 20: $5,242.88

Day 21: $10,485.76

Day 22: $20,971.52

Day 23: $41,943.04

Day 24: $83,886.08

Day 25: $167,772.16

Day 26: $335,544.32

Day 27: $671,088.64

Day 28: $1,342,177.28

Day 29: $2,684,354.56

Day 30: $5,368,709.12

2) Before completing the payment schedule, ask students if they notice a pattern and if they can develop a formula using the pattern. Engage students in a conversation about exponential functions. Have students look up the standard formula for exponential functions. Also engage students in a conversation about exponential growth and decay.
3) Ask students if they could go anywhere in the world, where would they go. Have students plan out their dream vacation.
4) Look up local bank interest rates on CD's. Explain to students how CD's work and how to look up the rate for CD's.
   Texas First: http://www.mytexasbank.com/CDRates/tabid/8072/Default.aspx
5) Based on students experience from writing the formula for the first question of this lesson, students should be able to write a formula for their savings plan. Have students write a formula for a 12 month CD in order to calculate how much they will have at the end of the 12 months. Ask students to determine if they will have enough money for their trip.
6) Tell students that they can let their money stay in for 4 years. Have them calculate how much they will have after four years.
7) Engage students in a conversation about what other options would students have to increase their money besides letting the money stay in longer.
8) Have students redo calculations in 8 and 9 with a larger amount of money in order for students to see what they would need to do in order to save enough money to go on their dream trip.
9) Also give students a standard rate, have them write a formula and calculate how long they would have to save their money in order to be able to go on their trip.
10) Show students videos about savings:
    http://www.youtube.com/watch?v=JuvhMva83ps
    http://www.youtube.com/watch?v=qHyJ1O6D32w

Homework: Engage students in multiple scenarios in which they are required to develop a formula to calculate the amount after a certain length of time.

Saving for the Dream Trip Worksheet

Name: ______________________________________

Date: _____________

1) If you were given a choice to receive one million dollars in one month or a penny doubled every day for 30 days, which one would you choose?

2) How much would you have in 30 days if you chose the second option?

3) What would be the function to determine the amount of money you would have in 30 days?

4) If you could take a trip out of state, where would it be?

5) Plane your trip.

a. Who all would you take with you? You will be paying for the individuals that are going with you.

b. How many days will you stay?

c. What dates will you travel?

d. Will you need a hotel?

e. Will you need a rental car?

6) Use Travelocity.com to determine the total cost of your trip.

7) How much money can you initially put into a savings account?

8) If you were to get a 12 month CD, how much would you have at the end of the 12 months? Will you have enough money to go on your trip?

9) If you were to get a 4 year CD, how much would you have at the end of the 48 months? Will you have enough money to go on your trip?

10) What could you do to gain more money?

11) What are some social inequities involved in saving?

12) What can you do to make a difference?